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A Survey of the

# Fire Houses of San Francisco

By H. C. VENSANO

Consulting Engineer

For S. P. DUCKEL

Director of Public Works

City and County of San Francisco

As Requested by

EDWARD P. WALSH

Chief Engineer of the Fire Department

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# SURVEY OF FIRE HOUSES

OF

SAN FRANCISCO

BY

H. C. VENSANO - CONSULTING ENGINEER

1951

FOR

MR. S. P. DUCKEL

DIRECTOR OF PUBLIC WORKS

OF

THE CITY AND COUNTY OF SAN FRANCISCO

AT THE REQUEST

OF

CHIEF ENGINEER, EDWARD P. WALSH

OF THE

FIRE DEPARTMENT

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Vensano, H. C.

Survey of the fire
houses of San Francisco
1951].

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September 12, 1951

Mr. S. P. Duckel
Director of Public Works
City Hall
San Francisco, California

Dear Sir:

I beg to submit herewith three copies of a Report entitled "Survey of Fire Houses of the City of San Francisco," as required under my contract with you dated March 14, 1951, and approved by the Controller March 28, 1951.

Respectfully submitted,

Consulting Structural Engineer
License #262

HCV/mc

## SURVEY OF FIRE HOUSES

## FOR THE CITY AND COUNTY OF SAN FRANCISCO

INTRODUCTION:

In 1939 the National Board of Fire Underwriters became interested in encouraging improvement in the fire protection system of this city of San Francisco, with the thought that any improvements made would have a favorable influence in the city's grading for fire insurance.

This matter was taken up by the Junior Chamber of Commerce and later backed by the San Francisco Chamber of Commerce as a project. As one part of this work the Junior Chamber initiated and backed an investigation of the fire houses of the city by Mr. Harold Engle, at that time Consulting Structural Engineer for the Board of Fire Underwriters of the Pacific.

This resulted in a Report by Mr. Engle dated March 15, 1940, directed to Mr. S. C. Abbott, Chairman of the Fire Safety Committee of the San Francisco Chamber of Commerce. This report severely criticized the entire group of fire houses of the city, some from a point of view of age, deterioration, decay and obsolescence for Fire Department's use, and all from the point of view that they were inadequately designed to resist lateral forces, including earthquakes, in an area recognized as one subject to seismic disturbances of considerable violence, and that as a result fire apparatus might be trapped in its station and men injured or killed by falling walls at a time when most needed.

This report was submitted by the Chamber of Commerce to the City for action.

Following receipt of the report, an effort was made to improve the design of newly constructed fire houses, but nothing was done to check Mr. Engle's report or to investigate and correct weaknesses in the buildings covered by the report.

In May, 1950, the Fire Safety Committee, Mr. D. P. Street, Chairman, of the San Francisco Chamber of Commerce in a letter to the Fire Commission of the City again revived this matter and asked that the Commission include $50,000 in their next annual budget to provide for surveys and plans for fire house improvements. This was done by the Fire Commission, but the amount was later reduced by the Board of Supervisors to $10,000. This amount the Fire Commission turned over to the Director of Public Works, Mr. S. P. Duckel to be used for purposes of investigation. This amount proved insufficient to pay for full investigations, mathematical analyses, and plans for reconstruction of 56 fire houses.

In view of this fact a contract for a limited survey and report was arranged for by the Director of Public Works, with the writer, a Consulting Structural Engineer, License No. 262, under date of March 14, 1951. This contract was certified by the Controller March 28, 1951.

Under clauses (2) to (7) of this contract which was duly signed and approved by all parties concerned it became the duty

of the writer to make a limited survey and investigation.

"2) To ascertain the condition of the existing fire houses in San Francisco from the point of view of sufficiency to resist lateral forces (earthquakes) in a way to protect the personnel of the department and assure the availability of the fire apparatus housed in them in time of earthquake or similar emergency."

"3) To ascertain in conference with Chief Edward P. Walsh, Chief Engineer of the Fire Department, the sufficiency for housing the department's manpower occupying said houses."

"4) To ascertain in conference with Chief Edward P. Walsh, Chief Engineer of the Fire Department, their sufficiency to accomodate modern fire-fighting apparatus in character and quantity necessary."

"5) To check the Report made by Harold M. Engle, Structural Engineer, to the San Francisco Chamber of Commerce on March 5, 1940 on the same subject."

"6) To visit and inspect each fire house (fifty six in number) and to make such reasonable inspection as may be possible without undue cutting of the construction materials of the building."

"7) To furnish three copies of written report to the Party of the First Part which shall discuss Mr. Engle's aforementioned Report, the sufficiency of each fire house, the advisability of repair of the same in a reasonable time,

the advisability of immediate or emergency repair and the the advisability for abandonment or reconstruction. Said Report to set up priority rating by groups which would indicate those buildings in need of immediate attention, those building which are less dangerous and on which work can be safely delayed, and those building which are safe and suitable for present needs of the Fire Department."

It is on the basis of such contract that this report is being rendered.

# R E P O R T

## INTRODUCTION:

My program for making this survey as first set up contemplated covering the city by districts, grouping the stations which were close together for visits at one time. I soon found however that such a procedure was impractical as it was found very confusing to visit a number of stations of widely divergent characteristics and types on the same day. After one or two false starts I found that by studying them in their order of age a much clearer structural picture could be obtained.

Such a survey and study in order of age, proved very interesting indeed as it brought out the developments leading to the fire house of today from the fire house of long ago.

## HISTORICAL:

The history of the group of fire houses now existing in the City of San Francisco, approximately 56 in number, began in 1876, when Engine House #14, located on McAllister near Webster Street was constructed.

The earlier built houses of which there now seems to be no records, were wiped out by the earthquake and fire of April 18, 1906. All such structures in the fire burned territory were, of course, destroyed. This burnt over territory may be crudely defined as that portion of the city lying east of the center line of Van Ness Avenue, extending southward and north of an irregular line, extending from 22nd and Valencia

Street to 3rd and Townsend Street at the channel and bounded on the north and east by the waters of the Bay. From such little information as is now obtainable, the buildings so destroyed, with possibly one or two exceptions seem to have been of frame, (i.e. wooden) construction. There seems to be no record that any of them fell. Apparently they were all destroyed by the fire that followed the earthquake. The statement has been flatly made by members of the Fire Department that no one was injured or killed by a fall of any of these buildings at the time of the 1906 earthquake.

Note: The death of Chief D. T. Sullivan, April 18, 1906, was due to falling walls of an adjoining building, crashing through the roof of the fire house.

In Mr. Engle's report he mentions that one fireman was killed and another seriously injured in a station located at that time at 3rd and Howard Streets. I have been unable to corroborate this.

As of 1906 there were two types of construction in use for Fire House purposes:

1) Frame construction, i.e., a building entirely of wood and

2) A building with similar interior wood framing but with exterior walls of brick (Defined as "Type C" in S. F. Building Codes previous to that of 1947.)

The frame type was probably the earliest type. No doubt it was used for economic reasons, but as time passed, this type gradually merged into wood interiors with brick outside walls and then into other types. The study of this development through the years has proved most interesting. The buildings were designed and built under the supervision of various architects, one succeeding another and each responsible for a certain group of stations. Architects are of necessity individualists, each having his own particular ideas structurally, as well as architecturally. The result of this has been that groups of fire stations are found to have group characteristics tied into a particular type of architecture for the group in question. In my opinion it is very doubtful that with one or two exceptions complete engineering analyses were ever made in the planning of any except the most recently designed stations. Apparently from time to time, designs were structurally strengthened, but only against vertical loads and as weaknesses in the previously built stations developed under the increasing loadings of the fire fighting apparatus.

However, except in the cases of two fire stations constructed since 1947 there is in my opinion no evidence to show that any analyses for lateral forces was ever made in the design of any of these fire houses. Such lateral strength as exists in them is there purely because it was inherent in the type of structure selected for use, and the result of gradual development from experience in the general use of such

common form of construction. Certain strengthening features were also possibly forced into them by provisions of the then in force San Francisco Building Codes, such provisions having developed from the same type of experience. For example, bond iron in brick walls, joist anchors at certain intervals between wood interior framing and brick walls, etc.

I might note there that while there have been numerous changes during the years since 1876 in the structural characteristics of our Fire Protection Stations, some for the better, others for the worse, but gradully leading to our more recent good structural designs; on the other hand the characteristics of the stations from the point of view of the needs of the personnel occupying them are much the same as they were in 1876. If anything, from this viewpoint they have deteriorated as a result of overcrowding resulting from the change from a single shift to a three shift basis.

It is to me surprising that little if any improvement in the facilities for personnel has been made during all these years. Today I hear public criticism that our newest stations appear as large rooming houses with a fire-fighting Apparatus Room as a secondary adjunct. Yet almost the newest house today (Engine #27) is already overcrowded.

There are today 10 frame stations and three brick walled stations still standing and in use which passed through the earthquake of April 18, 1906.

| | | | | |
|---|---|---|---|---|
| The Frame Stations are | Engine House | #14 | Built in | 1876 |
| | " " | #11 | " " | 1884 |
| | " " | #21 | " " | 1893 |
| | " " | #23 | " " | 1893 |
| | " " | #10 | " " | 1895 |
| | " " | #33 | " " | 1896 |
| | Truck House | #12 | " " | 1896 |
| | Engine " | #34 | " " | 1897 |
| | " " | #22 | " " | 1898 |
| | " " | #36 | " " | 1905 |
| | " " | #38 | " " | 1906 |
| The Brick Walled Stations are | Engine House | #13 | Built in | 1884 |
| | " " | #15 | " " | 1884 |
| | West Section of Truck " | #11 | " " | 1892 |

These are of great importance. A study of their action in the major earthquake of 1906 should give considerable information which should be of assistance in rating similar stations built since 1906 as to their earthquake resistant qualities.

Following 1906, seven frame stations were built, having most of the same general characteristics of the frame stations built before that time.

| | | | | |
|---|---|---|---|---|
| These were: | Truck House | #5 | Built in | 1907 |
| | Engine " | #7 | " " | 1908 |
| | " " | #31 | " " | 1908 |
| | " " | #40 | " " | 1910 |
| | " " | #44 | " " | 1910 |
| | " " | #42 | " " | 1912 |
| | " " | #43 | " " | 1912 |

Also following 1906, nine brick walled stations with frame interiors and very similar in most respects to Engine Houses #13 and #15, and to the west section of Truck House #11 were constructed.

| | | | | |
|---|---|---|---|---|
| These were: | Engine House | #1 | Built in | 1909 |
| | " | #2 | " | 1909 |
| | " | #41 | " | 1910 |
| | " | #45 | " | 1911 |
| | " | #24 | " | 1914 |
| | " | #48 | " | 1915 |
| | " | #18 | " | 1915 |
| | " | #46 | " | 1913 |
| | " | #26 | " | 1910 |

The chief development in this type of station between 1906 and 1918 was a gradual increase in strength of apparatus room floors under increasing motorized loads until the last ones were built with the apparatus room floors resting directly on the ground, the ultimate condition to produce maximum vertical load carrying capacity.

After 1913 the trend to brick or concrete wall stations became general and no further frame stations were built by the city until 1942 when Holly Park Station, Engine #32 largely a frame station was erected. Until 1916 single company stations had been the rule, but beginning in 1916 multiple stations came into general use and from then on types and characters of buildings varied widely.

It should be carefully noted and remembered that all stations built before 1912 were designed for horse drawn vehicles only. Motorized equipment first came into use about that time. The first station designed to accomodate the motorized type was I believe Engine House #6, designed in 1910 and built in 1912. Motorized equipment has progressively increased in weight since that time and all horse drawn equipment has long since been, of course, abolished; yet today we are housing

very heavy fire-fighting equipment in engine houses designed only for the light horse drawn loads. This is one of the greatest hazards inherent in the use of our present group of fire stations.

LIST OF STATIONS:

In Table II hereof are listed all fire houses in order of date of construction, together with their present station numberings in column No. 2 and their locations in column No. 3. Since some of these station numberings have been changed from time to time, I have in column 4 given the numbering or title for them as shown on the original architectural plans. This may be useful in coordinating the findings of this report with those of Mr. Engle, whose title or numberings may have been taken from the original plans.

For convenience I have also in Table III given the complete standard listing of these stations in consecutive numberings as used by the Fire Department. I believe the listing given in Table II by order of date of construction will be found to be more useful when studying this report.

PLANS OF STATIONS:

In connection with my survey the city was able to furnish me with plans for all fire houses built since 1906. For those built before 1906, no plans are available. All were lost apparently in the fire of that time. The survey of those stations for which no plans are available has necessarily been more difficult

# TABLE II

## LIST OF FIRE HOUSES

| (1) | (2) | (3) | (4) Original Title |
|---|---|---|---|
| 1876 | Engine #14 | McAllister St.nr.Market | Note: -All |
| 1884 | Engine #11 | Oakdale Ave. nr. 3rd | stations not |
| 1884 | Engine #13 | Valencia nr. 26th | listed in this |
| 1884 | Engine #15 | Calif. nr. Laguna | column were |
| 1892 | Engine #11 (West Sec.) | 315 Duncan St. | same as at |
| 1893 | Engine #21 | Oak nr. Divisadero | present. |
| 1893 | Engine #23 | Wash. nr. Broderick | |
| 1895 | Engine #10 | 17th nr. Folsom | |
| 1896 | Engine #33 | Broad nr. Plymouth | |
| 1896 | Truck #12 | Waller nr. Stanyan | |
| 1897 | Engine #34 | Ellis nr. Gough | |
| 1898 | Engine #22 | 10th Ave. nr. Judah | |
| 1905 | Engine #36 | 26th Ave. nr. Geary | |
| 1906 | Engine #38 | San Jose at Ocean Ave. | |
| 1907 | Truck # 5 | Geary nr.Divisadero | 16th and Albion |
| 1908 | Engine #7 | 16th St. at Albion - | St. Firehouse |
| 1908 | Engine #31 | Green St. nr. Jones - | North Side Green |
| 1909 | Engine # 1 | Pacific nr. Sansome | nr. Leavenworth. |
| 1909 | Engine # 2 | Bush nr. Kearny | |
| 1910 | Truck #11 (East Sec.) | 315 Duncan nr. Church | |
| 1910 | Engine #26 (West Sec.) | Sacramento nr. Maple - | Truck House #10 |
| 1935 | Engine #26 (East Sec.) | Sacramento nr. Maple - | Truck House #10 |
| 1910 | Engine #40 | Clayton at Clarendon | |
| 1910 | Engine #41 | Leavenworth nr. Clay | |
| 1910 | Engine #44 | 22nd nr. Castro - | Chemical Engine#11 |
| 1911 | Engine #45 | 45th Ave. nr. Irving - | Chemical Engine#12 |
| 1912 | Engine #42 | San Bruno nr. Silliman | |
| 1912 | Engine #43 | Brazil nr. Athens | |
| 1912 | Engine # 6 | 7th St. nr. Harrison | |
| 1913 | Engine #46 | 12th Ave. nr. Geary | |
| 1913 | Engine #28 | Stockton nr. Greenwich | |
| 1914 | Engine #24 | Hoffman at Alvarado | |
| 1915 | Engine #48 | Wisconsin at 22nd | |
| 1915 | Engine #18 | Girard at Wilde | |
| 1915 | Engine # 9 | Foot of Harrison | |
| 1916 | Truck # 2 | Powell nr. Broadway - | Engine #5 |
| 1916 | Engine # 3 | Post nr. Polk | |
| 1916 | Engine #12 | Drumm at Commercial | |
| 1917 | Engine # 8 | Pacific nr. Polk - | Engine #8 and |
| 1917 | Engine # 4 | Howard nr. New Montg. | Truck #5 |
| 1918 | Engine #17 | 416 Jessie St. | |
| 1918 | Engine #37 | 25th at Vermont | |
| 1923 | Engine #39 | 1091 Portola Drive | |
| 1925 | Truck # 1 | 420 Jessie St. | |
| 1926 | Engine #16 | Tennessee St. nr. 20th St. | |
| 1927 | Engine #25 | 3rd St. at Arthur Ave.- | Engine #19 |
| 1928 | Engine #19 | 4th and 3rd St. - | Engine #18 |
| 1928 | Engine #29 | Division & 11th St. | |
| 1928 | Engine #47 | 41st Ave. & Geary St. | |
| 1931 | Engine #49 | 18th Ave. & Quintara | |
| 1938 | Engine #20 | Greenwich nr. Steiner | |
| 1939 | Engine #35 | Bluxome nr. 5th St. | |
| 1940 | Utility Station | Octavia nr. Golden Gate- | Underwriters' |
| 1942 | Engine #32 | 194 Park St. | Building |
| 1950 | Engine #27 | Sanchez nr. Market | |
| 1951 | Engine #30 | 32nd Ave. near Ortega | |
| | Fire Boat #2 | Foot of Bay St. | |

# TABLE III

## LOCATION OF FIRE HOUSES

### ENGINE COMPANIES

1. 451 Pacific St.
2. 460 Bush Street
3. 1067 Post St.
4. 676 Howard St.
6. 356 Seventh St.
7. 3160 Sixteenth St.
8. 1648 Pacific Ave.
9. Foot of Harrison St.
10. 3050 - 17th St.
11. 1632 Oakdale St.
12. 115 Drumm St.
13. 1458 Valencia St.
14. 1051 McAllister St.
15. 2150 California St.
16. 909 Tennessee St.
17. 416 Jessie St.
18. 1298 Girard St.
19. 1300 Fourth St.
20. 2239 Greenwich St.
21. 1152 Oak St.
22. 1348 Tenth Ave.
23. 3022 Washington St.
24. 100 Hoffman Ave.
25. 3305 Third St.
26. 3767 Sacramento St.
27. 135 Sanchez St.
28. 1814 Stockton St.
29. 380 Division St.
30. 32nd Avenue nr. Ortega
31. 1088 Green St.
32. 194 Park St.
33. 117 Broad St.
34. 1145 Ellis St.
35. 36 Bluxome St.
36. 551 - 26th Ave.
37. 2501 - 25th St.
38. 2098 San Jose Ave.
39. 1091 Portola Drive
40. 1249 Clayton St.
41. 1325 Leavenworth St.
42. 2460 San Bruno Ave.
43. 724 Brazil Ave.
44. 3816 - 22nd St.
45. 1348 - 45th Ave.
46. 441 - 12th Ave.
47. 499 - 41st Ave.
48. 798 Wisconsin
49. 2155 - 18th Ave.

### BUREAU OF EQUIPMENT

840 Octavia St.

### TRUCK COMPANIES

1. 420 Jessie St.
2. 1340 Powell St.
3. Housed at Eng. Co. 3
4. Housed at Eng. Co. 8
5. 2136 Geary St.
6. Housed at Eng. Co. 27
7. Housed at Eng. Co. 10
8. Housed at Eng. Co. 35
9. Housed at Eng. Co. 37
10. 3767 Sacramento St.
11. 315 Duncan St.
12. 1757 Waller St.
13. Housed at Eng. Co. 12
14. Housed at Eng. Co. 36
15. Housed at Eng. Co. 39
16. Housed at Eng. Co. 20
17. Housed at Eng. Co. 11

### TANK WAGONS

1. Housed at Eng. Co. 28
2. Housed at Truck Co. 5
3. Housed at Eng. Co. 2
4. Housed at Eng. Co. 14
5. Housed at Truck Co.12
6. Housed at Eng. Co. 20
7. Housed at Truck Co.11
8. Housed at Eng. Co. 6
9. Housed at Eng. Co. 27
10. Housed at Eng. Co. 38
11. Housed at Eng. Co. 10
12. Housed at Eng. Co. 39
13. Housed at Eng. Co. 46
14. Housed at Eng. Co. 11

### FIRE BOATS

1. Housed at Eng. Co. 9
2. Foot of Bay St.

### WATER TOWERS

1. Housed at Eng. Co. 4
2. Housed at Eng. Co. 4
3. Housed at Eng. Co. 19
4. Housed at Truck Co. 2

### SALVAGE CORPS

1. Housed at Eng. Co. 5
2. Housed at Eng. Co. 27
3. Housed at Truc Co. 2

RD - Reconstruction Difficult

to make since all data for character of design, size and type of structural members had to be obtained by me in the field. Little money was available for opening up (and afterwards repairing) walls, flooring and other parts of the building necessary to expose details of construction for my information. Such work, under my contract is to be paid for by the City had therefore to be kept to a minimum. It should be remembered that in connection with those buildings which I shall hereinafter condemn for destruction and for which no plans have been available, that further confirmatory tests might in some cases be advisable before destruction is begun. Table I below gives a listing of engine houses for which no plans have been available.

TABLE I

ENGINE HOUSES FOR WHICH NO PLANS ARE AVAILABLE

| Built | Station No. | |
|---|---|---|
| 1876 | Engine #14 | No plans - frame construction |
| 1884 | " #11 | " " - " " |
| 1884 | " #13 | " " - brick, Class "C" construction |
| 1884 | " #15 | " " - " " " " |
| 1892 | Truck #11 (West Section) | " " - " " " " |
| 1893 | Engine #21 | " " - frame construction |
| 1893 | " #23 | " " - " " |
| 1895 | " #10 | " " - " " |
| 1896 | " #33 | " " - " " |
| 1896 | Truck #12 | " " - " " |
| 1897 | Engine #34 | " " - " " |
| 1898 | " #22 | " " - " " |
| 1905 | " #36 | " " - " " |
| 1906 | " #38 | " " - " " |
| 1907 | Truck #5 | " " - " " |
| 1935 | Engine #26 (East Section) | " " - " " |

SPECIFICATIONS FOR STATIONS:

A few only original specifications for the earlier buildings exist and have been examined by the writer chiefly to ascertain the character of brick, mortar and brickwork called for in their construction.

These early specifications appear to have been of a standard pattern - all alike in requirement for brickwork. The brick was required to have a maximum absorption factor not to exceed 15% and a minimum crushing strength of 1800 lbs. per sq. in. It was to be laid by shove joint method with every sixth course a header course, using a lime cement-mortar of 1 part of burnt lime to 8 parts of sand and gauged with one part of Portland Cement to 4 parts of the mixed lime mortar.

This specification does not seem to have met exactly the requirements of either the S. F. Building Code of 1906 or that of 1910. Both codes permit the use of either a 1:3 part cement mortar or a lime-cement mortar.

The 1906 Code required that lime-cement mortar be a mixture of 1 part of Portland cement to 6 parts lime-mortar while the 1910 Code requires that the lime-mortar be mixed in the proportion of 1 part burnt lime to 5 parts sand and afterwards gauged with 1 part Portland Cement to 6 parts lime-mortar. The Code of 1916 is identical in this respect with that of 1910.

The actual field tests of the brickwork of the various fire houses showed a wide variation in characteristics of both brickwork and mortar.

The original specifications covering "bond iron" and "joist anchors" seems to have been in accordance with the Code effective at the time.

The specifications for the most modern station of the Fire Department which has just been completed for Engine #30 on 32nd Avenue near Pacheco Street calls for mortar for use in the brickwork to be a cement mortar composed of one part of sand to 3 parts of Portland Cement gauged with 10% of well slacked lime putty.

FIRE DEPARTMENT ORGANIZATION:

Since I must ascertain the sufficiency of the existing stations for housing the Department's manpower, it might be well to review certain features of the organization of the Fire Department.

When the early stations were erected the Department operated on a one platoon system with the personnel of the Fire houses remaining on duty 24 hours per day with three days off per month -- all meals were eaten outside the station.

At the present time the Fire houses are operated on a theoretical two platoon system with a 56 hour work week and a third shift to fill in on holidays. Actually the operation is carried on by three crews or shifts, each working five 10 hr. day shifts, then 60 continuous hours off duty, then five 14 hour night shifts with again 60 continuous hours off duty.

In theory the Department furnishes each man and officer with a bed. The men and officers each furnishes his own mattress and bedding and pays for laundering it.

This system in effect requires under normal conditions that space be provided for three times as many beds as are actually in use on any one shift. In cases of emergency when all shifts might be called to duty at once, all beds might be in use at one time. Actually in numerous cases the houses are overcrowded. Beds cannot be provided for all and men and even officers must double up.

One meal, a luncheon, is now usually eaten by each shift inside the station. Kitchen facilities with small cook stove and sink are provided; also a space for a lunch table. The space provided for these facilities is small, in some cases much too small. In the older stations built in the time of the one platoon system, no kitchen-lunch space was provided but this has since been cared for by the introduction of kitchen-lunch room facilities into such odds and ends of space as existed about the station. For example, in no longer used Mezzanine floor haylofts, basement areas, in sheds or small wooden buildings, built in rear or side yard areas of the station.

Fire fighting equipment is assigned to each station and, is permanently located in that building. It is my impression that wherever possible the lightest and usually, therefore, the oldest apparatus is assigned to the stations having weak or overloaded (as indicated by previous repairs) apparatus room floors.

Unfortunately, at times of multi-alarm fires, where many pieces of equipment are called out at once, apparatus

from outlying stations is moved up into the vacated stations to help cover the territory that is left unprotected by the apparatus called to the large fire. This arrangement may at time of emergency force almost any piece of apparatus, light or heavy into almost any station weak or strong. In some cases the Fire Department personnel hesitate to drive the heavier apparatus into the new station and at times leave their equipment standing on the street instead.

Also at times relief and auxiliary apparatus are stored in the rear or to the sides of the apparatus room floors, adding to floor loads.

LOADS FROM FIRE APPARATUS:

At present one of the greatest sources of danger to the older stations is the ever increasing weight of the fire fighting apparatus.

I have been unable to obtain authoritative weights on the old horse drawn engines (steamers), but it is my impression that the maximum concentrated load caused by such horse drawn equipment could not have been more than about 2000 lbs. at any point, or on any wheel. Today rear axle loads on the heaviest fire fighting equipment run to 21,850 pounds for the heaviest hose tenders giving single concentrated wheel loads of 11,000 pounds at 6' 2" centers. Floors originally designed for the 2000 pound horse drawn loads are now supporting in many cases concentrated loads of from 7250 pounds to 8800 pounds (after

## TABLE IV

## FIRE APPARATUS - AXLE LOADS

(Equipment Fully Loaded)

| | | Axle Load | Maximum Wheel Concentration |
|---|---|---|---|
| Pumper (Light) | Front Axle | 6340 lbs. | 3170 lbs. |
| | Rear Axle | 11060 " | 5350 " |
| Pumper (Heavy) | Front Axle | 7300 " | 3650 " |
| | Rear Axle | 13200 " | 6600 " |
| Water Wagon (Light) | Front Axle | 6690 " | " |
| | Rear Axle | 10440 " | 5220 " |
| Water Wagon (Heavy) | Front Axle | 6360 " | " |
| | Rear Axle | 14500 " | 7250 " |
| Hose Tender and Battery | Front Axle | 6435 " | " |
| | Rear Axle | 10975 " | 5490 " |
| Fire Boat Hose Tender | Front Axle | 4550 " | |
| | Rear Axle | 21870 " | 11000 " |
| City Service Truck Hook & Ladder | Front Axle | 5630 " | |
| | Center Axle | 8030 " | 4015 " |
| | Rear Axle | 5810 " | |
| Areal Truck (Heavy) | Front Axle | 11430 " | |
| | Center Axle | 16170 " | 8095 " |
| | Rear Axle | 7760 " | |
| Areal Truck (Heaviest) | Front Axle | 12500 " | |
| | Center | 17700 " | 8850 " |
| | Rear Axle | 8500 " | |

Tread or transverse distance between wheels for "light" equipment is about 5' 2".

Tread or transverse distance between wheels for Heavy Modern equipment is about 6' 2".

Note:- This data was largely obtained from the officials of the Fire Department.

of course, various repairs, proppings up, strengthening, etc. to the floors in question have been undertaken.) Many of such floors are at present in very dangerous condition.

In Table IV may be found axle loads of various types of motorized equipment. The equipment shown as "light" are for the older units of the type in question, while the "heavy" types are the loads for the most modern types of equipment.

There is one special situation to be noted, however. Two hose tenders designed to carry 4000' each of 3-3/4" hose for use with two fire boats are especially heavy and were specially built to meet the City's specifications. It is said by the officials of the Fire Department that no additional such equipment will be constructed or necessary. It is this special apparatus that has the maximum rear axle load of 21,870 pounds. These two hose tenders are at present quartered in Engine House #19 and Fire Boat Station #2 on the waterfront and except in unusual emergency would not be moved to other quarters.

SURVEY PROCEDURE:

A synopsis of my finally adopted method of procedure for this survey was as follows:

1. Where plans were available I first studied them and then visited and inspected each fire house in order of age. The oldest first, making notes first as to sufficiency to accomodate their personnel and equipment and then as to evidences of structural weakness or deterioration. On these trips through the fire

stations I was always accompanied by the officer in charge of that particular station at the time of my visit. I wish at this point to acknowledge my obligation and appreciation to these men for the courtesy shown and assistance given me throughout this work.

2. After such visits I made requests to the Director of Works for such cuttings and opening up of existing structures as I found to be absolutely necessary for an understanding of the structural features of the building in question. Under the terms of the contract such work was to be done and paid for by the city. Included in these field tests was a program for cutting at least one test hole in the brickwork of each brick building to ascertain the quality and workmanship of the material in that particular structure. At the time of such cutting I accompanied the crew doing such cutting work at all times, re-visiting for the second time each such station, accompanied by Mr. Walter Zecher, Assistant Superintendent of the Bureau of Building Repair of the Department of Public Works of the City. Mr. Zecher and I viewed the actual cutting of the brickwork throughout the entire time required for the operation to personally obtain first hand knowledge as to its character, the hardness of the brick, hardness and bond of the mortar and character of workmanship, particularly as to the fullness of mortar joints. Mr. F. Geaney was the operator who actually handled the air hammer and did the cutting, assisted by John Hoagland.

Other openings were made in floors and walls by a carpenter of the Building Repair Bureau, acting under instructions from me given through Mr. Zecher. The results of this portion of the investigations were in some cases transmitted to me by written reports by Mr. Zecher who obtained his information from the carpenter. In other cases I was present when the work was done or revisited the job if it seemed desirable or necessary.

3. I then made a study of records of the natural foundation materials (surface and subsoil strata) at each of the fire house sites where such records were obtainable. The character of the natural foundation on which it stands is I believe extremely important in influencing the behavior of the structure under seismic force.

4. With the results of the field work at hand my final studies were completed and recommendations were drawn up.

Note: While it was necessary for me to read Mr. Engle's report before I could properly start the survey I avoided any serious analyses of his recommendations and discussion of individual fire stations until my own findings were completed and in writing. I did this in order to avoid as far as possible being influenced by his findings.

The following ratings for quality of the brickwork were set up at the time of making the tests of brickwork for strength and stability and are used hereinafter:

Brick Wall - Standards for Ratings

1) "A-1" - "1st Class" or "Excellent" - Brick hard; Mortar hard; Joints completely filled and Bricks "Well wetted." (This latter being shown by no separation of mortar from brickwork in such a way as to leave a clean brick surface.

2) "Good"- Brick medium hard - Mortar Hard - Brick well wetted - Joints 90 - 95% full.

3) "Good but Weak" - Workmanship same as item (1) but Brick and Mortar "Soft;" resulting in a wall "Good" but structurally weak - requiring use of low stresses for load carrying calculations.

4) "Fair"- Brick medium hard - Mortar medium hard - All joints except Vertical transverse joints of header courses full. But Vertical transverse joints of headers only one-half filled, i.e., the inner half length of such joints largely free of Mortar. (This is a common method of "Skinning" a 17" wall.

   Or same as above with vertical transverse header joints full but vertical longitudinal joints 50% open.

5) "Poor"- Brick work with both Transverse and longitudinal joints - 50% open.

6) "Very Poor" - Mortar "Soft" (Lime) and all three types of joints partly open or one type consistently and largely open.

## STRUCTURAL DISCUSSION

### EARLY FRAME CONSTRUCTION:

In the early stages, beginning in 1876, all stations were designed for horse drawn equipment. The horses were housed in the station building alongside of the fire fighting apparatus. The resulting loads were very light, compared to those of our present motorized equipment. These early buildings usually of frame construction designed in rectangular shape from 25' to 30' wide and two stories in height. A partial or full basement was used, intended for storage of coal and other supplies. The apparatus occupied a central longitudinal area in the first or apparatus room floor with horse stalls on each side against the side walls of the station. Automatic arrangements freed the horses and dropped their harness on to them as they of their own knowledge moved from their stalls to their places along the shafts of the fire apparatus when the fire alarm sounded. The apparatus room almost always occupied the entire first floor of the station and was entirely devoid of partitions, except for a mezzanine floor hayloft, carried transversely or crosswise of the apparatus room. This hayloft was about 10' wide with tightly closed wooden side walls, reaching from the Mezzanine floor level to the ceiling. The Mezzanine floor level was about one-half the height of the first story. This Mezzanine was constructed at a position one-half to two-thirds of the length of the apparatus room back from the front wall of the station.

From the point of view of resistance to lateral forces, it was a very important feature of the station. It was the only lateral interior brace in the first story of the building. This first story was usually about 19' high and the second or dormitory story about 12' high from floor to ceiling line. Except for the hayloft construction, the building was entirely dependent for lateral strength in the first story on its front and rear walls which were normally and often necessarily full of window and door openings. They therefore added little to the lateral strength of the structure.

The second floor was occupied by the Men's dormitory, two small private rooms for the officers; limited lavatory and bathing facilities for men and officers, and a modest sized room called a "Sitting room." There was no "communications" room separately partitioned off as today, and no space for desk work or report writing. Apparently fire alarm sounding equipment and all functions of operation were carried on in the open floor area of the apparatus room.

This second or dormitory floor was supported by wooden joists running transversely of the building and carried by its side walls. They fully spanned the apparatus room below, i.e., 25' to 30'. The first or apparatus room floor was similarly carried by transverse joists, except that their span was halved by a longitudinal girder located on the center line of the apparatus room and running from front to rear of the building.

This girder was in turn supported by wooden or cast iron columns, spaced from 10' to 12' centers through the basement area and by short wooden posts through partially excavated areas, where no basement existed.

Second story floor was double, consisting of a layer of sub-flooring 7/8" thick and a 7/8" x 4" T & G finished flooring. The first floor normally consisted of a 2" thick subflooring and a 1-3/4" x 4" T & G finished flooring. Walls were much to my surprise "Western" type of construction at first and second floor levels. In only one case was balloon construction reportedly found. Balloon construction was used in all cases at the top of the building for supporting the trussed rafters.

Note:- Definition:- "Western construction" is that now in general use in residential building in our city wherein the walls consist of studs cut to story height, resting on a single 2" thick plate nailed to the flooring of the story below and capped by a double capping of 2" thick material, nailed to the studs and supporting the ends of the joist of the floor above. These joists are solidly bridged at their ends above this capping. This type of wall framing has of itself no vertical continuity at floor level and therefore no ability to resist vertical bending from lateral forces. It does, however, give a floor diaphragm, capable of transmitting lateral forces to the walls of a structure.

"Balloon construction" as often used in early times consisted of side walls whose studs ran continuously past floor levels and had the floor joists spiked to them by means of nails through the webs of the joists. These joists were further supported by a continuous 1" x 3" or 1" x 4" horizontal ribbon gained 1" into the face of the studding. The joists rested on this ribbon and were in part carried by it and in part carried by the web nailing. This type of wall construction being continuous at floor lines can take vertical bending from lateral forces. But the flooring stopped off at the face of studs cannot serve so well as a horizontal diaphragm to carry lateral loads to the end walls.

In many cases the outside walls were doubly sheathed. A layer of 7/8" thick diagonally or horizontally laid boards back of a layer of 7/8" rustic or shiplap. This feature undoubtedly added materially to the resistance of these old frame stations to the lateral forces coming to them in the earthquake of 1906.

As did also the fact that interior walls and ceiling of all these pre-1906 stations were sealed throughout the first story with 7/8" T & G lumber. The group so sealed included Engine Houses 11, 14, 21, 22, 23, 10, 33, 34 and Truck #12. In Engine Houses #36 and #38 built in 1905 and 1906 respectively, and in Engine Houses 7, 31, 42, 43 and Truck #5, built after the earthquake the designers went a step further and sealed both stories throughout with this T & G material. The only exceptions to

this practice were Engines #40 and #44 which were plastered inside throughout.

As a part of these early stations, there was always a hose tower carried above the roof or a height of about 14' to 20'. The purpose of such tower was to hang hose when wet for drying. Standard practice was to hang twenty 50' lengths of fire hose in such tower. Said hose I am informed weighs about eighty pounds per length when dry and from fifty to seventy-five per cent more when wet. The total resulting load being from 1600 to 3000 lbs. These hose towers were so constructed that in general their weight was in large part carried on the roof supports of the stations. These towers are a definite element of danger when lateral forces are considered. In some cases they have been removed. The roof supports which carry them are usually ceiling joist and roof joist, Howe trussed together, with 1 x 6 or 1 x 8 diagonal and vertical web members to form a parallel cord roof truss or rafter. These trussed rafters varied center to center from 24" to 32" and in depth from 2' 6" to 4' 6".

I have gone into great detail in describing this old time type of station, since with gradual modification it served as a basis for all later types up until the year of about 1916 when multiple stations came into general use. Even these, however, followed a somewhat similar pattern until about 1920 when variations in plan from simple rectangular type of building became general, and more complicated architectural types were introduced.

There is no record that any of these frame stations failed during the 1906 earthquake, nor have I been able to develop any evidence to show that they were seriously racked or damaged by that earthquake. I mention this particularly at this point since Mr. Harold Engle has assumed in his report that these buildings were probably so severely damaged by the earthquake of 1906 that they could not safely resist a similar quake in the future. A careful and complete examination of truss joists in the attic spaces of these buildings shows no evidence of any kind that such racking seriously affected them. All lumber was found sound, with joints tight, and nailing undamaged either by racking of the quake or to any extent by rust through the long period of years that has elapsed since their construction.

Mr. Engle in his Report stated in the last paragraph on page 3:

> "Many of the Stations went through the 1906 shock and it is a certainty that while damage was evidently minor the nailing in general was loosed up. In another severe shock, their behavior would be somewhat questionable, with partial transverse collapse not at all out of the realm of possibility."

On page 2 in paragraph one he elaborates further, I quote:

> "There is a widespread fallacious idea that because a building survived one severe shock without falling down, it is a fine earthquake risk and

immune to damage in the event of another severe shock .... The Helena, Montana shock of 1935 did much to show how incorrect such an idea is, due to the fact that three heavy shocks in close succession showed clearly how slight or moderate damage caused by the first shock was intensified up to point of actual collapse in the third shock."

Note:-(The emphasis by underscoring is mine. But it might well be asked "What in case no damage were caused by the first shock?")

On the basis of such thought he condemns apparently all buildings built prior to 1906 and which went through the earthquake of that year. This reasoning he would apply in particular to ten wooden and three brick wall stations still standing and in use.

However, I have made I believe quite a thorough study of the framing of these wooden buildings that went through the earthquake of April 18, 1906 and find not the slightest evidence that the wooden framing and jointing of such stations were in any wise weakened or damaged thereby. I have personally visited the attic spaces of most of these buildings and much to my surprise have found the lumber sound; all joints tight and apparently no evidence of strain or deterioration of any kind. It is in this upper part of the framing of the structure where the greatest seismic effects would be expected. My findings were

so universally true that in only two individual joints in all of these buildings did I find any defect at all and in those two cases the defects could have been of original workmanship. These facts are true in spite of the fact that in theory the nailing, even under normal vertical loads only, is quite light.

In order to be on safe ground in making the foregoing statement I went so far as to have nails removed from several joints in each of fifteen buildings, some of them frame and some of them the brick walled type, in an effort to find out if slippage of the joints might not have occurred at the time of the 1906 quake and the evidence of it having since been concealed by time and dust. My thought was that by careful nail pulling it could be ascertained whether or not nails might have been kinked by slippage between the boards of the joint at the time of the quake. It also was thought that this test would show whether any joint weakening had occurred by rusting of the nails during their long life in the structure since 1906. No evidence of kinking was found and the amount of rusting was insignificant.

Two kinds of nails had been used. In the early structures cut nails of wrought iron were found. In a few cases there had been a little rusting at the nail head, but the bodies of the nails were all practically rust free and in some cases showed in considerable part the original polished finish. When it is remembered that some of these nails had been in place for 74 years, this test offers still another proof of the rust

resisting qualities of wrought iron. In other later constructed buildings, the present day type of wire nails had been employed. These showed in some cases coatings of rust, but in no case of such sufficient importance in my opinion as to seriously weaken the holding power of the joint.

The above discussion of nail tests applies only to the construction in the attic space. No special investigation of nailing was made at first or second floor levels, but here also visual inspection showed no open or racked joints.

The final result of my inspection of frame buildings of the group which had passed through 1906, leads me to believe that there was no damage whatsoever caused by that earthquake on the type of frame structure then in use for fire house purposes, and that similar stations built since must be considered to be equally earthquake resistant.

Unfortunately, however, various changes have occurred or been made in them since that time. Decay, overloaded apparatus floors and removal of mezzanine floors have greatly changed their status as safe structures for present use. All such factors have been considered and weighed in my final decision as to their disposal. The point I wish to make here is that I cannot agree with Mr. Engle that these frame structures must be discarded simply because they passed through the earthquake of 1906.

The principal structural weaknesses to be investigated today in the group of frame stations are:

1) Weaknesses in apparatus room floor and its supports due to overload, possibly accompanied by rot.

2) Instability against lateral forces (wind or earthquake) due to the removal of the Mezzanine Floor Hayloft construction without the introduction of other equivalent bracing features.

3) Danger from improperly or unscientifically supported hose towers. (This may be considered a minor and rather easily curable weakness).

4) Insufficiency and character of Natural Foundations tions, i.e. whether "Good," "Fair," or "Poor."

5) Insufficiency of living quarters of the personnel, particularly from the point of view of overcrowding but also considering obsolescence and depreciation.

6) Deferred Maintenance - as an added cost in a Program of Reconstruction.

Note:- I have defined the ratings for "Natural Foundations" in general as follows:

"Good" - Rock, shale, or level beds of sand of considerable extent, especially if overlaying rock or shale.

"Fair" - Sandy Clay, Dry Clay, Sand on sloping areas.

"Poor" - Filled ground, or clay or sand over original marshland or old creek bed areas (Whether building has been built on pile foundations or not).

Of the foregoing, the first "the safety of the Apparatus Room Floor is the most difficult to pass upon. The question of a standard is at once raised. For what load must a floor be sufficient and when stressed at what unit stresses? The danger involved in the continuing use of floors in some of these buildings is great.

In discussing this situation with Chief Walsh of the Fire Department, I asked him how I was to rate fire house floors from point of view of safety. He ruled very properly in my opinion that an apparatus room floor must be ruled unsafe unless it can take any piece of equipment owned and operated by the Fire Department and included in this ruling the fire boat hose tenders, the special piece of apparatus having a rear axle load of 22,000 pounds and a concentrated wheel load of 11,000 pounds. Such ruling, if rigidly applied would rule out as dangerous almost all present buildings whose apparatus room floors are not supported directly on the ground. A study of Table IV indicates that with the exception of this special equipment, the maximum wheel load or any other piece of apparatus would be 8,850 pounds which is that of a maximum areal truck. The two fire boat hose tenders are regularly housed on the waterfront and as already stated are never expected to be housed elsewhere. However, in time of special emergency it might happen.

At this point it should be recognized that the criteria for the destruction (or reconstruction) of a building already constructed cannot and should not be based on the same rigid

requirements, in my opinion, as those required for a building which is to be newly constructed. The cost of strengthening new buildings to meet standards of safety may be quite small, while that of destroying a whole building quite serviceable under somewhat lesser standards, would, of course, be 100%. Remodeling in some cases may also be a large proportion of the total original cost.

The decision setting limiting standards for rating these old and weak structures has been one of the most difficult problems of this report. For purpose of new construction a minimum Apparatus Room Floor loading of an 11,000 pounds concentration should be used as ruled by Chief Walsh.

It perhaps should be said here that in general though not necessarily in particulars as to the various stations, my report will be in agreement with that of Mr. Engle's. The program of replacement and reconstruction recommended will be of considerable cost. A large number of the stations should either be abandoned, or partially reconstructed if they are to be brought into a safe condition. It will obviously be impossible to do all work needed at once so that time is involved. In view of these facts it becomes important that no building that can be salvaged or put into a safe condition for temporary use should be overlooked. Our standard, I believe, therefore, must be lowered as far as reasonably possible to permit buildings, which are obsolete, overloaded or overcrowded and which

therefore are actually due for abandonment, to be used a reasonable while longer through a period of emergency reconstruction.

Therefore, in arriving at my final recommendations herein I have indicated the maximum allowable wheel load for each station which may be continued in use temporarily or permanently. With this loading I am also permitting a 50% overloading of existing floors at ordinary design stresses.

The officials of the Fire Department should note this carefully, and if these recommendations are adopted, keep the heavier types of apparatus out of fire houses so limited until the entire reconstruction is completed and all fire stations have been brough up to full Standards as set up by Chief Walsh and discussed elsewhere herein.

Partial justification for such overload may be found in the fact that the timber in use in these early times was actually of greater strength, grade for grade, than that in use today. Also, some of these floors under heavy overloads have shown little signs of distress and of this I have taken account in arriving at my final recommendations for treatment of the various stations.

It should be noted that it is impossible to completely replace a first or apparatus room floor in these buildings of Western Construction without completely wrecking the side walls. Such a condition will make reconstruction economically unfeasible for any frame station whose floor is completely gone.

So far I have not mentioned decay or dry rot. These defects have been mentioned though not particularly stressed by Mr. Engle.

It had been in the past a common occurrence to find rotted joist and other lumber beneath the first floor at points under the horse stalls where the urine of the horses had worked its way down through the wooden floor and its support. The bulk of rotting that has been found in the past and which has since largely been repaired (by crude replacements) has resulted from this cause. In my survey only a limited amount of unrepaired rotting was discovered. I have in a very few cases also found local infestation by termites. Considering the frame stations as they stand today, however, rot and termites are not the main hazard. They have been considered in my final decision as to necessity of floor replacement.

The second principal structural weakness has been listed above "Instability against lateral forces including earthquake." As already stated I believe this frame group has sufficient stability against lateral forces <u>as they originally were constructed</u> to resist another quake of equal intensity to that of 1906. Unfortunately, in later years after the introduction of

motor vehicles the Mezzanine Floor Hayloft was, in many cases, removed. This was unfortunate. It was practically the only real brace in the first story and its removal left the station a definite and dangerous earthquake hazard. In some cases an effort was made at the time of removal to substitute as a stiffening factor various types of knee braces between side walls and second floors. None of these as they now stand would in my opinion prove effective. One type which consists of 2 x 4 or 2 x 6 knee bracing members at least 5' 0" in height (there are some only 3' 0") spaced 16" centers on each side for the full length of the apparatus room and at present toe nailed in place with three nails at each end, might be made effective by proper increase in the strength of their end connections by use of side plates or straps of plywood or steel with increased nailing. Where such a possibility exists and where apparatus room floors are still usable, I am rating the station as a Reconstruction Project. Otherwise where Mezzanine Floors have been removed I must rate them for Abandonment and Demolition.

The third element of weakness, common to both the frame type of station and the earlier brick wall type, is the hose tower, supported in large part by the truss roof rafters. These hose towers commonly overload the truss rafters, especially their nailing. In a number of cases temporary and in some cases unscientifically designed supports have been added for additional support to their inside corners. This seems to indicate

previous trouble in connection with this feature of the stations. In my recommendations hereinafter it should be noted that even though a frame or brick wall type of building has been passed as safe or listed for reconstruction, the hose tower should be especially investigated at time of reconstruction to see that the truss roof rafters supporting such tower are sufficiently strengthened by double nailing or otherwise as may be necessary to insure the safety of the support of the tower.

In some cases these hose towers have been removed and replaced by longitudinal hose racks on the roof. Here again care must be exercised to see that we have not gone "from the frying pan into the fire" especially where the roof racks have been located longitudinally along the center line of the roof, possibly thereby overloading the truss roof rafters in bending.

In general the removal of a hose tower is a move toward safety when lateral forces are considered.

The "Insufficiency of these frame stations to longer meet the needs of the Personnel" and the subject of "Deferred Maintenance" will be discussed later herein under those headings.

## CLASS "C" and "B" BUILDINGS

(Classifications Pre 1947 Building Codes)

Turning now to the brick walled and later types of fire houses, we find the designers gradually strengthening their buildings to resist increasing vertical loads. This undoubtedly forced upon them at first by increased weights of motorized fire fighting apparatus and later because of widened buildings for multi-company occupancy. However, as herein previously stated, there is no evidence that the design of any of these stations up and until 1947 were ever figured to resist any lateral forces whatsoever either from wind or earthquake.

Progressive changes in design took the following sequence:

Group I - Brick and stone exterior walls with wood interiors.

Brick and stone walls were early introduced in a few stations, notably Engine Houses #13 and 15 and West Section of Truck #11, all constructed prior to 1906 and passing through that quake. In this type the interior framing was of wood, similar in nearly all respects to the typical frame stations already described. This type was still in favor following 1906 and buildings for Engines #13, 15, 1, 2, 18, 24, 26, 41, 45, 46, 48 and Truck #11 (West Section) were built along very similar lines. However, after the construction of Engine Houses #1 and #2 in 1909 the old type of wood supported Apparatus Room floor was abandoned. Reinforced Concrete and Structural Steel supported

## TABLE V

## TYPE OF APPARATUS ROOM FLOOR SUPPORT

| | | | |
|---|---|---|---|
| 1876 | Engine #14 | | Wood Framed |
| 1884 | Engine #11 | | " " |
| 1884 | Engine #13 | | " " |
| 1884 | Engine #15 | | " " |
| 1892 | Truck #11 | (West Section) | " " |
| 1893 | Engine #21 | | " " |
| 1893 | Engine #23 | | " " |
| 1895 | Engine #10 | | " " |
| 1896 | Engine #33 | | " " |
| 1896 | Truck #12 | | " " |
| 1897 | Engine #34 | | " " |
| 1898 | Engine #22 | | " " |
| 1905 | Engine #36 | | Wood Joist - Steel Girders |
| 1906 | Engine #38 | | " " " " |
| 1907 | Truck # 5 | | Wood Framed |
| 1908 | Engine # 7 | | Wood Joist - Steel Girders |
| 1908 | Engine #31 | | Wood Framed |
| 1909 | Engine # 1 | | " " (Originally -Now on |
| 1909 | Engine # 2 | | " " ground) |
| 1910 | Truck #11 | (West Sec.) | Concrete Slab on Ground |
| 1910 | Engine #26 | (West Sec.) | Wood Joist - Stud Girders |
| | Engine #26 | (East Sec.) | Wood Framed |
| 1910 | Engine #40 | | Wood Framed |
| 1910 | Engine #41 | | Wood Joist - Steel Girders |
| 1910 | Engine #44 | | Wood Framed |
| 1911 | Engine #45 | | Reinforced Concrete |
| 1912 | Engine #42 | | Concrete Slab on Ground |
| 1912 | Engine #43 | | Concfete Slab on Ground |
| 1912 | Engine # 6 | | Reinforced Concrete Floor-Pile Found- |
| 1913 | Engine #46 | | " " " ations. |
| 1913 | Engine #28 | | Structural Steel and Concrete |
| 1914 | Engine #24 | | Concrete Slab on Ground |
| 1915 | Engine #48 | | Structural Steel and Concrete |
| 1915 | Engine #18 | | " " " " in part rest |
| 1915 | Engine #9 | | Supported on Wharf on ground. |
| 1916 | Truck #2 | | Structural Steel & Concrete |
| 1916 | Engine #3 | | Structural Steel " " in part rest on |
| 1916 | Engine #12 | | " " " " ground. |
| 1917 | Engine # 8 | | Concrete Slab on ground |
| 1917 | Engine # 4 | | Structural Steel and Concrete |
| 1918 | Engine #17 | | Structural Steel and Concrete |
| 1918 | Engine #37 | | Concrete Slab on ground |
| 1923 | Engine #39 | | Concrete Slab on ground |
| 1925 | Truck # 1 | | Reinforced Concrete |
| 1926 | Engine #16 | | Concrete Slab on ground |
| 1927 | Engine #25 | | Reinforced Concrete on Concrete Piles |
| 1928 | Engine #19 | | Reinforced Concrete on Concrete Piles |
| 1928 | Engine #29 | | Concrete Slab on ground |
| 1928 | Engine #47 | | Concrete Slab on ground |
| 1931 | Engine #49 | | Concrete Slab on ground |
| 1938 | Engine #20 | | Concrete Slab on ground |
| 1939 | Engine #35 | | Reinforced Concrete |
| 1940 | Utility Station | | Concrete Slab on ground |
| 1942 | Engine #32 | | Concrete Slab on ground |
| 1950 | Engine #27 | | Concrete Slab on ground |
| 1951 | Engine #30 | | Concrete Slab on ground |

concrete slab floors came into some use and finally as in the case of the frame buildings, the concrete slab supported directly on the ground became the accepted solution.

Group II. Brick exterior Walled Wood interior type with partial interior frame of Structural Steel. These steel frames varied from simple steel girders carried on the side brick bearing walls of the building and carrying the wooden part, to frames having interior columns, beams and girders, but still supported by exterior bearing walls. (This Group includes Engine Houses #12, 4, 28 and Truck House #2.)

Group III. Similar to above, except that the brick exterior walls of the building were changed to 17" x 17" bearing piers with 13" curtain walls between piers. (This group includes Engine House Nos. 16, 29 and 39.)

Group IV. Buildings with complete structural steel frames including exterior wall columns introduced at least into the Apparatus Room section of the building and with brick Curtain Walls. In no case, however, until 1947, were these frames designed to take lateral forces. (This group includes Engine Houses #3, 8, 19 and 25.)

Group V. Same as IV with Walls of Structural Terra Cotta Tile. (This group includes Engine Houses #20, 49 and 47.)

Group VI. From time to time an occasional building with Reinforced Concrete Frame and outside walls, but wooden floors and roof or wholly of Reinforced Concrete, Class "B" type was constructed. This group includes Engine House Nos. 6 and 35 and Truck #1.

Group VII. There still remain unclassified Engine House #32 completed in 1942 of wood with partial Steel Frame; Engine House #9 and Fire Boat Station #2, both on the water-front which are frame throughout and owned by the State Harbor Commission; our two newest engine houses #27 and #30, completed in 1950 and 1951, respectively. These last two were constructed to meet all the safety provisions of the 1947 Building Code of San Francisco.

Note:- Listed in above groups have been included for purposes of this discussion twin as well as single unit stations when of similar construction.

STANDARDS FOR LATERAL FORCES:

In these groups the chief structural weakness will be found in their insufficiency to withstand earthquake forces. For the correction of this deficiency a standard of lateral strength must be set up. Possibly one might assume that the lateral force provisions of the present (1947) San Francisco Building Code should be accepted as a proper standard. However, as I have said before herein, but it will bear repeating, "It does not seem reasonable to apply the same rigid standard of safety to a determination as between the complete destruction or salvage of an existing useful building as would

be applied to new construction. "Safety requirements of our Building Codes add in general only modest additional costs to the entire overall cost of the structure, but to destroy a building because it does not meet completely such standards is quite a different matter."

It is recognized by all structural engineers that lateral force provisions are a controversial subject and that standards even in Building Codes are note yet well established. The coefficient of lateral forces set up in the 1947 San Francisco Code represents, however, the opinion of ten of San Francisco's most prominent licensed structural engineers collected and mathematically averaged by the writer at the time that Code was compiled. I believe they still represent the best standards available for new work. To the best of my belief, nothing new of scientific knowledge in the correlation of our knowledge of seismic waves with their effects on buildings has developed since that Code was written. I, therefore, recommend that all of these Buildings which are to be reconstructed be strengthened to meet the coefficients of that Code. However, where it is impossible or economically unfeasible to accomplish this, I believe that about two-thirds of these values should be considered acceptable as an alternate to abandoning a station. My own recommendations will be based on this standard.

The standards for floor construction used in study and decision in connection with all these groups will be the same as that set up herein previously in discussion of frame type. The problem of first floor safety, however, becomes less important in these groups since most of the floors in these buildings built after 1910 had been either materially strengthened in comparison with earlier designs, or were designed ground supported.

Group I. The Brick walled type of building of Group I as built and in use today is not susceptible of rigid mathematical calculation as now required by Building Codes.

However, three of these structures actually went through and survived the earthquake of 1906 with different degrees of success. They were Engine Houses #13 and #15 and West Section Truck #11.

The history of and experience with them should, I believe be given serious consideration in rating similar stations in terms of lateral load stability and safety.

Accurate information as to these structures has been difficult to obtain because of lapse of time. The Fire Department personnel who actually worked and lived in them in 1906 have passed on. Information can be obtained only second-hand from other older time station inhabitants who received their information from those who actually experienced the earthquake

of 1906 while in those stations. Another source of meager information has been from citizens who still survive who lived in the neighborhood of the station in question at the time of the quake. Such information by word of mouth has been supplemented as far as possible by such physical evidence as can be found in the buildings today. My findings in connection with each of these three stations are as follows:

All three were brick walled wooden interior stations as typically described under "Frame Stations hereof with the exception of the substitution of brick outside walls for wooden ones. Front and rear walls were full of openings. Interior of outside walls were plastered instead of sheathed with T & G.

Station #15 was highly ornamented with cast cement ornaments and apparently should have been dangerous from this source and subject to serious damage, yet the station went through the entire experience unscathed except possibly for a cracked retaining wall in the rear of the lot.

The facts as to Truck #11 at 315 Duncan Street are somewhat in doubt. No evidence has been obtainable from Fire Department employees. Neighborhood residents disagree. One party claimed no damage, the second, Mr. Frank Kelly, at present Chief of the Fire Prevention Bureau claims that the top of the front wall was thrown off down to the level of the top of the second story windows. He resided in the neighborhood of Truck #11 as a boy. This latter view seems to be corroborated by the

appearance of the upper front corner of the west side wall of the station which shows reconstruction at that point. The brick work there seems to be a re-used brick and has a different color and appearance from the rest of the wall. Nothing can be told from the appearance of the top of the front wall itself since it has been painted over several times.

In the case of Engine House #13, the facts are more definite. In this case, the rear wall was, almost for its full height, thrown to the ground, one of the side walls had to be shored up from an open lot next door to prevent its fall outward and there is a vague report that the front fire wall may have fallen. This seems doubtful.

Since these stations are similarly constructed, why did these different results occur? After field tests of brick work and a study of natural underlying foundation conditions, the reasons appear clear. In the case of Engine #15, the brick work was found to be good with all joints well filled with mortar. In the case of Truck #11, the brick work was only fair with some open joints. In the case of Engine #13 the brick wall and mortar of the side walls were soft with joints only partly filled and rated as poor. (A test of the brick work of the rear wall of this station showed a different quality of brick work, somewhat harder and better than the side walls. This difference of character of brick work is confirmatory evidence that the original wall fell and was rebuilt.

As to Natural Foundations, Engine #15 stands on a sand bed over rock, rated as good. Truck #11 stands on clay, probably over rock, but with continuous circulation of water through it as evidenced by basement leakage. Engine #13 is located on or close to the edge of an area which is the extension of what was originally a swampy creek area.

Good brick work and good natural foundations were apparently the salvation of Engine House #15. Poor brick work and questionable foundations explained the collapse of Engine House #13 with Truck #11 in between.

As a result of this study of these stations, my recommendations on brick wall stations of Group I have been heavily weighted by the type of brick work found in them and the type of natural foundations upon which they rest.

## STRUCTURAL WEAKNESSES OF CLASS "B" AND "C" STATIONS BY GROUPS

Unfortunately while during this progression of design types, designs were improved in point of strength under vertical loads, the general trend when considering their strength to resist lateral forces was with few exceptions actually in the opposite direction.

The later groups (considering the period before 1942) were actually more earthquake hazardous than were the older groups as originally constructed.

While poor brick work and poor natural foundations are regarded as the most important general element of risk in all these groups, each group has its own particular weaknesses of design.

GENERAL WEAKNESSES:

Among weaknesses common to all Class "C" stations and to be considered in all complete Engineering Studies later approved by the City whether specifically mentioned in my "Recommendations for Individual Fire Houses" as found in the Appendix hereof or not are the following:

1. Danger from heavy ornamental features of stone, architectural Terra Cotta and Terra Cotta roofing tile on fire walls, mansard roofs or awnings overhanging front wall or main doorway of building.

2. Danger from weakly supported interior corners of hose towers, usually supported on the trussed roof rafters.

3. Danger from poor and obsolete lighting systems in many older stations. These are of the knob and tube type of construction (now illegal) and are as a result an ever present fire hazard.

4. Many openings in front and rear walls.

5. In many stations almost all reinforced concrete apparatus room floors are overloaded when calculated for standard loads under present day allowable steel stresses. It should also be noted by any engineer who may hereafter check the stresses in these floors that concrete in 1916 or earlier was usually mixed on the job and that it was not uncommon to find 28 day tests of such concrete to have a compressive strength of as little as 800 pounds per square inch. 1500 lbs. per square inch in those days was considered good concrete. However, in no case have I observed any cracking of any of these floors and I am, therefore, rating them as "sound" and accepted them all as "safe" during any reasonable reconstruction period for their present normal apparatus loads. Additional investigations and analyses of strength should be made during that period for all portions of such floors. The Fire Department should bear this in mind in the meantime and keep the heavier type of fire hose tenders off of them. I have endeavored to be somewhat more specific on this point in my

Individual Recommendations in the Appendix hereto. But it should be noted that information as to amount and character of reinforcing steel is quite limited in some of the older sets of plans.

6. Character of brick work.

7. Character of Natural Foundations.

## CLASS "C" STATIONS - GROUP I

In Class "C" - Group I. the walls with many openings, and with floors which have not been designed as horizontal girders or diaphragms, as required by modern structural engineering thinking, are the weakest features. (What lateral strength exists in this group is as has been previously stated only that inherent in it from practical development over a long period of construction of such common type of structure.) In my recommendations I have given consideration to this inherent strength.

In some cases they can be reconstructed to meet mathematical requirements. In many cases the second floors of these buildings have been built with double thicknesses of wood flooring. Due to this fact I believe they can be rather easily developed as horizontal diaphragms by the addition of proper wall connections. If end walls require strengthening, openings may in some cases be closed or the wall possibly may have to be rebuilt or stiffened by the addition of structural frames of steel or other suitable material. The reconstruction of end walls is, of course, a major reconstruction. In the Table below I have indicated certain major characteristics for each of these Group I, Class "C" Buildings, with my Recommendations in the last column.

## CHARACTERISTICS OF CLASS "C" BUILDINGS

### GROUP I

| Name | Natural Foundations | Brick Work | Floor Supports | Recommendations |
|---|---|---|---|---|
| Engine #13 | Poor | Very Poor | Poor | Abandon |
| Engine #15 | Good | Excellent | Dangerous | Reconstruct floor only |
| Truck #11 | Fair | Poor | " | Abandon |
| Engine # 1 | Fair to Poor | Poor | OK | Abandon |
| Engine # 2 | Fair | Good but Weak | Limited Load | Reconstruction |
| Engine #26 | Fair to Good | Poor | " " | Abandon |
| Engine #41 | Fair | Poor | " " | Abandon |
| Engine #45 | Good | Poor | " " | Abandon |
| Engine #46 | Good | Good | " " | Continued use |
| Engine #24 | Good | Excellent | OK | Continued use |
| Engine #48 | Excellent | Excellent | OK | Continued use |
| Engine #18 | Fair | Varies | OK | Reconstruction |

In the Appendix to this report will be found detailed recommendations for these stations.

## CLASS "C" STATIONS - GROUP II

In this group are Class "C" buildings with brick and Terra Cotta outside walls, generally rectangular in plan and two-stories high, as in the previous group, but with partial interior steel frames supporting wooden floor joists and flooring. These have no steel columns in the exterior walls. These walls act as bearing walls, carrying the concentrated loads brought upon them from steel beams and girders. In my opinion this type is in more danger from earthquake forces than are the stations of Group I in which the above-mentioned concentrations have been uniformly distributed to the outside wall by floor joists and roof rafters. It should be noted that the thickness of these bearing walls as used in general was the same in both Groups I and II and are with few exceptions 17" thick in the first story and 13" thick in the second story. The front walls are somewhat thicker and vary in design with the architectural features.

In this group also we find the other weaknesses of design, common to those in Group I, walls having many openings and roofs and floors not designed as horizontal diaphragms. Also, in both groups we have overhanging masses of architectural Terra Cotta or brick which in most cases should be removed. Where in this group brick work has been rated "Poor," I am recommending that the building be abandoned as I believe that reconstruction requiring as it would the complete replacement

of the outside walls cannot possibly be economically warranted. Those having brick work rated "Fair" or "Good but structurally weak," have been included with those whose brick work has been rated "Good" or "Excellent" in the Class for possible reconstruction, following a complete engineering analysis and study by some competent licensed structural engineer.

In rating these as reconstruction projects, I am not guaranteeing that the cost of such reconstruction will fall within reasonable economic limits, but I do think that the possibilities for salvage are sufficiently good to warrant the necessary full engineering studies. In the Table below I am giving certain characteristics and my recommendations for these stations.

| | Normal Foundations | Brick Work | Apparatus Room Floor | Recommendations |
|---|---|---|---|---|
| Engine #12 | Fair | Very Poor | OK | Abandon |
| # 4 | Probably Poor | Excellent | ? | Reconstruction |
| #28 | Good & Fair | Fairly Good | OK | Reconstruction |
| Truck # 2 | Fair | Excellent | ? | Continued Use |

In the appendix to this report will be found detailed recommendations for the stations of this group.

## CLASS "C" STATIONS - GROUP III

In this group are included those stations with exterior walls of brick and Terra Cotta, having partial interior steel frames, carrying wood floor and roof joists and in general similar to those of Group II except that the exterior bearing have now become 17" x 17" brick bearing piers usually about 20' centers and laterally supported in the plane of the wall by 13" curtain walls, often pierced by many windows or other openings. These piers have no transverse bracing. Neither is there in many cases a spandrel beam in the plane of the curtain walls.

This class of building is, I believe, almost certain of complete collapse in any major earthquake. Certainly so if the brick work is rated as "Fair" or "Poor."

I amrating them as immediately dangerous and recommending the entire group for abandonment. I believe satisfactory reconstruction is economically unwarranted and would be almost as expensive as would be a new building.

Fortunately, there are but three stations in this group and one of them Engine #29 is already slated for removal due to the requirement of the property on which it stands

by the widenine of 13th Street. The remaining two are Engine House Nos. 16 and 39.

Detailed recommendations will be found in the Appendix of this report.

## CLASS "C" STATIONS - GROUP IV

In this group are buildings similar to Groups II and III, but with steel frames, complete in the sense that they include exterior wall columns. This frame is steel used to carry wooden construction at the second floor and roof joists. Such frame may not exist in all parts of the building but has been at least provided in the walls and frame of the apparatus room.

In Engine Nos. 3 and 8 the columns of the frames are very light and would have to be strengthened to take the lateral forces. In view of the fact that these stations are very much overcrowded and that their reconstruction would probably be expensive, abandonment may be found advisable. Engine #8 might be expanded into a vacant lot next door, as a twin station. If that were done, lateral support for the present station might be built into the new section and the reconstruction might be economically warranted.

Reconstruction of Engine House Nos. 19 and 25 is practical and in my opinion will be found to be economically warranted projects.

## CLASS "C" STATIONS - GROUP V

In this group of stations are included Class "C" buildings, with complete structural frames, but with structural tile used for their exterior walls in the place of brick work. This frame as before may encomapss only the Apparatus Room, the rest of the station being of brick exterior walls and wood interiors. These stations are three in number and include Engine House Nos. 20, 47 and 49. This group also lacks any lateral stability and the Terra Cotta Tile walls should be removed and the steel frame stiffened to resist lateral forces equivalent to those required by the City's 1947 Building Code. This can be done at reasonable cost, I believe, provided those portions of the stations being outside the steel frame usually of brick and wood construction are found after full engineering study to be already safe. The portion of the station without steel frame should be carefully studied for weaknesses.

## CLASS "B" AND "C" STATIONS - GROUP VI

There are but three stations in this group. Engine House Nos. 6, 35 and Truck #1. Engine House #6 is a complete Class "B" design. (This rating is as per Building Codes previous to that of 1947). Engine #6 is in perfect shape, apparently though of early design and seems to be supporting all present rather light apparatus room floor loads properly. No cracks are anywhere visible in the concrete.

However, since its original construction a 12" thick layer of rock filling with an additional concrete wearing surface 4" thick has been placed on top of the old apparatus room floor (apparently to raise its level at some time when the grade of 7th Street was raised). Remembering that it was originally designed for Horse Drawn Vehicles it would seem that this 1st floor under Motorized equipment and such fill must be seriously overloaded.

Also, it is highly doubtful that any mathematical calculations for lateral forces were made in its design. However, the inherent natural strength of this "B" type Building warrants a complete engineering study of all its parts before any final disposition can be made of it. If it is weak it will be hard to strengthen, so in my opinion the result of such analysis will either result in a decision for "Abandonment" or "Use as is." Possibly the overloading fill on 1st floor could be removed and ramps to street substituted.

I would advise that a complete check by a competent licensed Structural Engineer on the bases of the subnormal 8850 lb. Standard Wheel Load and for lateral forces based on two-thirds the value of the Coefficients set up in the San Francisco Building Code of 1947, be immediately authorized.

Engine House No. 35 has a completely reinforced concrete frame with reinforced concrete exterior walls but with wooden joist construction in the second and third floor and roof. This as in the case of Engine House #6 shows no evidence of any weakness, but should be similarly rechecked. I believe this design may be found already laterally stable.

Truck House #1 is in the first story and basement of a seven-story Class "B" reinforced concrete building originally built by Hale Bros. for their own use, with this portion leased to the city for fire house purposes. The analysis of such a structure is entirely beyond the scope of this report. There are some structural tile partition walls between the sections of this station and, I believe, between it and the other portions of the main building. No complete plans are available to me. It might be well to remove these tile partitions and substitute metal lath and plaster or other similar construction.

I think it is safe to assume that the general strength of the seven-story building is probably equivalent to other buildings of that type throughout the city but probably not up to present lateral force standards as measured by the Building Code of 1947.

## GROUP VII - UNCLASSIFIED

In the unclassified group there remain two new stations Nos. 27 and 30 placed into service respectively in 1950 - 1951 which have been designed by licensed structural engineers of good reputation and under the provisions of the 1947 Building Code. There is no reason to doubt their safety from both vertical and horizontal loadings.

Also, in this Group is Station #32. This properly should have been discussed under the heading of frame buildings since it is of frame construction with a partial structural steel frame. It was, I believe designed without any special study of lateral forces. It is also I believe entirely safe under vertical loads. A complete study of this station by a licensed structural engineer from the point of view of possible seismic loads should be made. It is possible that some additional lateral bracing may be advisable in it.

Also, in this group are Engine House #9 and Fire Boat Station #2 which are of frame construction, built by the State Harbor Commission in the Waterfront Wharves, along the Embarcadero. They are owned by the State Harbor Commission and subject to their jurisdiction. Individual Recommendations for all these two stations will be found in the Appendix.

## CONCLUSIONS - CLASS "B" AND "C" GROUPS

I have grouped the Class "B" and "C" Stations by type of design, chiefly because such design groupings are basic measures of the ability of a station to resist lateral forces.

I have tabulated certain of their characteristics above by groups to draw special attention to the nature of my recommendations as related to "brick work" and "poor foundations." These final recommendations have been based on considerations of many points of both strength and weaknesses in each case, as well as on the character of brick work and foundations. However, I believe it would be a dangerous error to permit any station to remain in use whose brick work has been rated as "very poor" or "poor" irrespective of all other considerations. Where brick work has been rated "fair" and other points have been in favor of the station, I have made my recommendations to provide for a complete engineering study, although "fair" brick work in my opinion is a rather serious earthquake hazard.

In connection with my recommendations for "abandonment" and "reconstruction," it should be understood, of course, that any type of construction can be reconstructed if enough money is expended. Where "abandonment" is recommended I have done so because I feel that there is little doubt that if reconstruction had been recommended the cost would have exceeded any possible value of the resulting structure.

Throughout this Report I am using the term "Earthquake Resistant" rather than "Earthquake Proof" because the maximum possible severity of earth shock is unknown and probably greater than ever so far experienced anywhere. By "earthquake" resistance" I intend to convey the thought that a building so rated would in my opinion withstand safely a shock of equal severity to that of April 18, 1906.

## STUDIES AND CRITERIA

In arriving at my final recommendations I considered in each case the following extensive list of good and bad features applying to individual stations. For the group of Frame buildings:

1. Natural Foundations.
2. The original plans when available.
3. Strength of Apparatus Room Floor from point of view of design.
4. Strength of Apparatus Room Floor from point of view of condition of materials - dry rot, termites, etc.
5. Lateral stability from the point of view of design.
6. Did it go through 1906 earthquake?
7. Is Mezzanine Hayloft still in place?
8. Strength of substituted knees, if any.
9. Balloon or Western Construction.
10. Outside sheathing - double or single.
11. Character of interior finish - T & G, O.P., or Plaster.
12. Number and size of openings, particularly in front and rear walls.
13. Condition of trussing in the attic space from point of view of design.
14. Condition of trussing in the attic space from point of view of soundness of lumber.
15. Condition of trussing in the attic space from point of view of nailing and tightness of joints.
16. Number of bracing partitions in first and second stories.
17. Floors as horizontal diaphragms.
18. First and second floors - number of wood layers and their thickness.
19. Ornaments or roofing tile overhanging front wall.
20. Character and extent of deferred maintenance.
21. Character and condition of yard structures.
22. Quarters from point of view of the personnel.
23. Specially for overcrowing or shortage of lavatory and toilet facilities.
24. Sufficiency of Lighting System.
25. Sufficiency of Heating System.
26. Character of Sewage Discharge.
27. Hose Tower Condition, if still in place.
28. Character of Gasoline Storage Facilities.
29. Area of kitchen-lunch room space.

For CLASS "B and "C" BUILDINGS, I have considered:

1. Natural Foundations.
2. The Original Plans if available.
3. Strength of Apparatus Room Floor, Point of view of Design.
4. Strength of Apparatus Room Floor, Point of view of condition.
5. Lateral stability as designed.
6. Character of Brick work.
7. Thickness of walls.
8. Bond Iron.
9. Joist Anchors.
10. Did it pass through 1906 or is it like one which did?
11. Number and size of openings in walls, especially front and rear.
12. Is Mezzanine-Hayloft still in place?
13. Is there a Hose Tower still in place and its condition?
14. Type of steel frame.
15. Trussing in attic space character of design.
16. Condition of trussing in attic space - soundness of lumber.
17. Condition of trussing in attic space - tightness of joints and nailing.
18. Number of bracing partitions in first and second stories.
19. Floors as diaphragms.
20. Overhanging stone or Terra Cotta Ornamental features of front wall.
21. Overhanging roofing tile.
22. Character and condition of yard structures.
23. Quarters from point of view of Personnel.
24. Specially as to overcrowding and shortage of bathing and toilet facilities.
25. Sufficiency of Lighting System.
26. Sufficiency of Heating System.
27. Character of Sewage Discharge.
28. Character of Gasoline Storage Facilities.

Note: Notes on all these points are on record in my office but of necessity cannot be repeated fully herein without making this Report burdensome.

## STRUCTURAL SUMMARY

Summarizing and generalizing briefly the major structural defects of all the Fire Houses, the frame stations in their condition as originally constructed were in my opinion "earthquake resistant" and would have passed safely through an earthquake of the severity of that of 1906 except for some ornamentation overhanging the front wall and main entrance. Since that time the removal in many cases of their Mezzanine Hayloft floors, which had been one of the most important lateral braces, has made them dangerously weak against seismic forces.

Another and equal danger has developed through the overloading of their Apparatus Room floor in the transition from light horse drawn fire equipment to the present day heavy motorized type, except in the few cases where the apparatus floor is supported directly on the ground.

These two weaknesses practically eliminate all but a very few frame stations from long continued use, aside from their obsolescence and insufficiency as quarters for the Fire Department Personnel.

The overloaded apparatus room floor is a danger almost generally also among all the Class "C" and "B" stations where apparatus room floors are not ground supported. While many of

these Classes have reinforced concrete floors or of structural steel with reinforced slab type. These types also would be in general heavily overloaded under a Standard 22,000 lb. axle (or 11,000 lb. wheel load). The primary weakness in these floors is usually in the floor slab itself. But the most important and dangerous weakness in the Class "B" and "C" group lies in the complete disregard of lateral forces by their planners. They are with a few exceptions dangerous earthquake hazards.

Unfortunately the above weaknesses, combined with in some cases their complete obsolescence as satisfactory living and working quarters for the Fire Department Personnel, should eliminate at once at least two-thirds of all stations. Since this is not possible, I have been forced to quite liberal standards of safety in an endeavor to set up a group of stations which by limitation of Apparatus Room loads and temporary rebracing of frame structures can be recommended for continued temporary use. Engineering studies recommended in connection with the rating for "Reconstruction" should be authorized at once. They take time and many of the stations carrying this rating are at present serious earthquake hazards as they now stand.

## MAINTENANCE

In general the exterior maintenance of all these fire stations has been in the past abominable. The interior maintenance may be rated as fair or worse. Apparently insufficiency of funds has been the controlling cause. What moneys have been available have been spent on the inside of the stations to maintain the moral of the personnel and little or nothing has been spent on the outside. The result of this deferred maintenance has now reached the point where in any reconstruction program considerable sums will have to be spent--much more than would have been spent, had proper outside maintenance been performed in time.

The chief deficiency has been in lack of paint and little attention to roofing other than patching to correct leaks. Asphalt recoatings or replacement of roofing as a whole has seldom if ever been done insofar as I can ascertain, with the result that many of the older roofs give trouble with leaks almost every winter with resulting damage to interior painting, and plastering and rotting of interior woodwork, etc. The lack of paint has resulted in windows which, in almost every station, rattle and whose sashes in many cases have dried out and shrunk to the extent that they are actually coming apart at the corners. Instead of painting, the habit has been to repair such open corners with small metal plates, screwed in place. Similarly skylights, roof flashings, down spouts,

lintels and other outside metal work are in many cases rusting for long time lack of paint. As one example of the extravagances of this type of deferred maintenance is a case at Engine House #24, 100 Hoffman Avenue. This building has three second story windows in its rear brick wall over which are three steel lintels, making a practically continuous line of steel across the rear wall. To have painted these three lintels would have required about $1.00 worth of paint and one hour of labor every three to five years, or a total of possibly $30.00 in the twenty-seven years of the life of this structure. Instead of this, these lintels have rusted and the accumulated and expanding rust has cracked the building wall for its full width and has raised and separated the top 6' of the wall from the rest of it. This is an immediate hazard in any earthquake since it overhangs the rear yard of the station. It probably would cost $2,000 or more to reconstruct this portion of the wall. Many other examples might be similarly given.

In some cases this deferred maintenance has been no doubt the result of the thought especially in the case of frame buildings, that these buildings are obsolete and will soon be replaced. If my recommendations herein are followed this will not necessarily be so as several of the brick stations are in a much more immediate dangerous condition than are some of the wooden ones.

In endeavoring to give these various stations priority ratings for destruction, I have endeavored to include in a general way the cost of deferred maintenance as a part of the total cost of reconstruction.

Out of my own experience as Director of Public Works for the City in 1942 to 1950, I can appreciate the shortage of building repair funds, since these were in large measure set up in the budgets of my Department. It was required during those years that the budget of the Work Department cover all maintenance requirements of all buildings of the Police Department, Fire Department, Park-Recreation Department, as well as of the City Hall and the Hall of Justice. These requirements were to be set up as a single budgeted item. After a careful survey of all badly needed repairs and maintenance work, the sum set up was often quite considerable, but when the budget had been finally approved and passed the amount actually made available for the work was seldom more than half the amount requested. Such unrealistic budget cutting as practiced over the years by the budget control officials is largely responsible for the meaintenance deficiencies existing in these Fire Stations today.

The money recently made available for their repair is now so small that in many cases it has not been possible to make minor needed repairs, such as repairs to leaking shower stall floors, etc. I have in my notes several cases in which three shower stalls exist in a fire station, yet only one has been usable over a period of many months or even years. This type of situation does not add to the morale of the Fire Department Personnel. Men coming in from a major conflagration in a hot, sweating and dirty condition need immediate bathing facilities.

## SUFFICIENCY OF QUARTERS FOR PERSONNEL

The question of the sufficiency for the quarters for the personnel is one that I do not feel particularly qualified to discuss. I have, of course, discussed it with the various officials of the Fire Department and with the station officers with whom I have visited. There are many points which should be given consideration. First, of course, and easy to evaluate is the condition of crowding. As mentioned hereinbefore the growth of organization from a one platoon to practically a three-shift operation has loaded the older stations with three times the number of beds for which they were designed. This makes the dormitory area what amounts to a bed storage warehouse. There is no space left in the dormitory for other than actual sleeping quarters. Also, in very few cases even in the newer stations do the dormitories meet the Standards set up as necessary by Chief Edward P. Walsh of the Fire Department requiring 3' between beds.

The increase in number of officers has also resulted in a shortage of private sleeping facilities and has forced in many cases two Lieutenants into one room, designed for a single individual. In other stations where more than one company is housed some of the officers are obliged to sleep in the open dormitory with the men. Crowding must also be considered from another point of view; that of sufficiency of lavatory, toilet and bathing facilities. There are in some.

stations where multi-companies have been introduced as few as two toilets for 42 men. Of course, only one-third of these men are at the station at one time under any but emergency conditions. I have already mentioned the shortage of showers due to lack of proper maintenance.

Considering the sufficiency of quarters from other points of view, it must be recognized that firemen exercise their functions largely in a physical way and must therefore be at all times in good physical condition, e.g.,. such work as dragging of heavy hose, raising of long ladders by hand and then climbing same, and possibly carrying a citizen from a burning building, all requiring well conditioned muscles. In a recent fire a fireman while carrying heavy hose into a burning building died of a heart attack.

Even as designed today there is no space provided in the station for any form of exercise. In some cases the men themselves have constructed undersized handball courts in yard spaces and in one instance at least, a man who used to be a weight lifter before he was a fireman, actually has his weights stored on the upper platform in the hose tower in a dark area not over 5' x 8' in size to which place he retires daily to exercise for about an hour.

One of the worst features of the stations on an average are their poor and in many cases obsolete lighting systems. The wiring is often of the knob and tube type now illegal and a constant fire hazard. In some cases open lights are still

in use -- very bad on the eyes, and in nearly all cases fixtures and their globes are long ago outmoded. The men in some instances have run wires to the head of their beds and installed crude reading lights at such points.

The heating systems are usually satisfactory.

In many stations no private space has been provided for the officers in which they may do their desk writing of reports and the like.

Nearly all stations today have what is called the communication room where the fire alarm signal apparatus is set up. In the older stations where such space was not originally partitioned off on the apparatus room floor, partitions have been constructed following the removal of the Mezzanine Room Haylofts. Such partitions (have little value in stabilizing the structure against lateral forces, but do) separate a space for use as a communications room. In this room in many cases the officers must do their work while the men use it as a sitting, reading, talking, television, billiards and at times, where kitchen-luncheon spaces are unusually small, it is even used as a place in which to spread their luncheons.

While I must apologize for endeavoring to advise on a subject rather new to me, it would seem that there has been lack of initiative in improving a bad situation which has persisted for many years. It would appear that dormitories might be designed with double bunks or some form of wall beds or other contrivance by which at least two-thirds (the unused

two-thirds of possibly all of the beds) could be stored in the daytime, leaving the dormitory area for use with gymnasium apparatus.

It seems entirely possible that bed manufacturers could design a special Fire House bed and frame carrying three springs, mattress, etc., two of which could be raised and stored at ceiling level while not in use. Such contrivance might not bee too good looking but would save much floor space in existing (or new) stations and eliminate present "crowding."

I am informed by one officer that wall-stored beds have been tried in New York, but that such arrangement was found unsatisfactory due to the fact that the stored beds give off disagreeable body odors. To me in this day of modern venitlation systems, I see no reason why such a condition could not be readily cured. I feel also that a good sized outdoor handball court would not be an unreasonable adjunct to every station (unless such activity would be thought to interfere with a prompt reply of the men to the fire alarm).

Kitchen-luncheon room spaces should be properly located (as has usually been the case in newer stations) and made of a size more in proportion to the size of the crew occupying the building.

Private space for routine office work should be provided for the officers.

Lack of proper storage facilities for gasolene for the fire-fighting apparatus is common in all stations built before 1913 when motorized equipment was first introduced. These stations are equipped with one or two 50-gallon capacity hand buggies, a short supply in case of city-wide catastrophe and somewhat of a fire hazard in itself.

I might note that in a few cases, stations have been crowded due to the fact that they have been set up as battalion quarters for officers where no extra officers' rooms had been provided.

Even today's crowded accomodations for personnel were only obtained in the early built stations by reconstruction which eliminated "Sitting Rooms", "Rig Rooms," "Drying Rooms" and the like from the second floor thereby providing additional dormitory space.

At present as many as 42 men are housed in quarters originally designed for 16.

Today, even one of the most recently built stations, Engine #27 at 135 Sanchez Street, completed in 1950, is already overcrowded with six officers of one company sleeping in two beds. The excuse for this is that while the house was designed for two companies, three companies are now occupying it. This is said to be temporary until new quarters for the third company can be provided, but being very familiar with the difficulty and time consumed in obtaining funds for new construction in our city, I suspect that this condition will

persist for several years, perhaps longer.

Table #VI Gives a summary of some statistics measuring "overcrowding."

In connection with recommendations for "Continued Use" or "Abandonment" it is difficult to evaluate "Overcrowding" since this at any time might be reduced in the case of individual stations by the regrouping of personnel and equipment or by the construction of a greater number of stations.

## TABLE VI

## QUARTERS AND OVERCROWDING

| | | Rating | Men | Beds | Toi-lets | Show-ers | Work Rooms |
|---|---|---|---|---|---|---|---|
| 1876 | Engine #14 | Crowded | 24 | 23 | 3 | 2 | 4 |
| 1884 | Engine #11 | Much Overcrowded | 42 | 16 | 3 | 2 | 4 |
| 1884 | Engine #13 | " " | 24 | 17 | 2 | 1 | 3 |
| 1884 | Engine #15 | Crowded | 24 | 21 | 2 | 3 | 3 |
| 1892 | Truck #11 | " | 33 | - | 3 | 3 | 4 |
| 1893 | Engine #21 | " | 21 | 21 | 2 | 2 | 3 |
| 1893 | Engine #23 | Satisfactory | 21 | 21 | 2 | 2 | 3 |
| 1895 | Engine #10 | Short of Facilities | 48 | 48 | 2 | 2 | - |
| 1896 | Engine #33 | Satisfactory | 15 | 15 | 2 | 2 | 2 |
| 1896 | Truck #12 | " | 27 | 27 | 3 | 3 | 5 |
| 1897 | Engine #34 | Crowded | 21 | 21 | 2 | 3 | 6 |
| 1898 | Engine #22 | Satisfactory | 15 | 15 | 3 | 2 | 3 |
| 1905 | Engine #36 | Much Overcrowded | 36 | 29 | 2 | 2 | 4 |
| 1906 | Engine #38 | " " | 27 | 22 | 2 | 2 | 4 |
| 1907 | Truck # 5 | Crowded | 27 | 25 | 2 | 2 | 3 |
| 1908 | Engine # 7 | " | 24 | 21 | 2 | 2 | 3 |
| 1908 | Engine #31 | Satisfactory | 15 | 15 | 2 | 2 | 2 |
| 1909 | Engine # 1 | Somewhat Crowded | 21 | 21 | 2 | 2 | 2 |
| 1909 | Engine # 2 | Satisfactory | 24 | 24 | 2 | 3 | 5 |
| 1910 | Engine #26 | Much Overcrowded | 39 | 30 | 4 | 4 | 6 |
| 1910 | Engine #40 | Crowded | 20 | 18 | 2 | 2 | 2 |
| 1910 | Engine #41 | Short of Facilities | 19 | 17 | 1 | 3 | 2 |
| 1910 | Engine #44 | Satisfactory | 15 | 15 | 2 | 2 | 3 |
| 1911 | Engine #45 | " | 15 | 15 | 2 | 2 | 3 |
| 1912 | Engine #42 | " | 15 | 15 | 2 | 2 | 2 |
| 1912 | Engine #43 | " | 15 | 15 | 2 | 2 | 3 |
| 1912 | Engine # 6 | Much overcrowded | 39 | 24 | 2 | 2 | 3 |
| 1913 | Engine #46 | Satisafactory | 27 | 27 | 5 | 3 | 5 |
| 1913 | Engine #28 | Crowded | 24 | 22 | 2 | 2 | 5 |
| 1914 | Engine #24 | Satisfactory | 15 | 15 | 2 | 2 | 2 |
| 1915 | Engine #48 | " | 15 | 15 | 2 | 2 | 2 |
| 1915 | Engine #18 | " | 15 | 15 | 2 | 2 | 2 |
| 1915 | Engine # 9 | Much overcrowded | 48 | 39 | 5 | 2 | 7 |
| 1916 | Truck # 2 | " " | 38 | 38 | - | - | - |
| 1916 | Engine # 3 | Crowded | 39 | 28 | 3 | 2 | 5 |
| 1916 | Engine #12 | Satisfactory | 51 | 49 | - | - | 14 |
| 1917 | Engine # 8 | Much Overcrowded | 42 | 34 | 4 | - | 7 |
| 1917 | Engine # 4 | " " | 48 | 30 | 3 | 3 | 4 |
| 1918 | Engine #17 | Crowded | 21 | 21 | 3 | 1 | 4 |
| 1918 | Engine #37 | Much Overcrowded | 38 | 28 | 3 | 2 | 4 |
| 1923 | Engine #39 | " " | 42 | 22 | 3 | 1 | 4 |
| 1925 | Truck # 1 | Slightly Crowded | 37 | 37 | - | 2 | - |
| 1926 | Engine #16 | Much Overcrowded | 24 | 22 | 3 | 3 | 4 |
| 1927 | Engine #25 | Satisfactory | 18 | 17 | 3 | 3 | 4 |
| 1928 | Engine #19 | " | 25 | 25 | - | - | - |
| 1928 | Engine #29 | - | - | - | - | - | - |
| 1928 | Engine #47 | Satisfactory | 15 | 15 | 3 | 2 | 3 |
| 1931 | Engine #49 | " | 24 | 24 | 5 | 3 | 4 |
| 1938 | Engine #20 | Much Overcrowded | 42 | 27 | 4 | 3 | 6 |
| 1939 | Engine #35 | Slightly Crowded | 42 | 41 | 3 | 3 | 6 |
| 1940 | 840 Octavia St. | Satisfactory | - | - | - | - | - |
| 1942 | Engine #32 | " | 15 | 15 | 2 | 2 | 2 |
| 1950 | Engine #27 | Overcrowded | 84 | 50 | 5 | 4 | 10 |
| 1951 | Engine #30 | Satisfactory | - | - | - | - | - |
| | Fire Boat #2 | Short of Beds | 34 | 31 | 2 | 1 | 4 |

Note:- Number of Toilets, Showes and Wash Basins listed are generally for men only. Officers usually have one of each for the private use of their group.

## REPORT OF HAROLD M. ENGLE

Referring now to Mr. Harold Engle's Report it can be said at once that with all his general comment and criticism I am, with one important exception, in hearty accord.

I agree that San Francisco lies in a recognized earthquake belt and that our Fire Stations will be sooner or later subjected to earthquakes of greater or lesser severity. All seismologists recognize and accept this to be a fact. I also agree that there is no recognized limit to the possible severity of such shocks and that the fact that we have not experienced one of any severity for a good many years only brings the next one nearer. I believe all seismologists will agree with this statement too.

I agree that the types of structure used in design for fire houses between 1906 and March 15, 1940, the date of Mr. Engle's Report were in general badly chosen for an earthquake region and I have found many of them to be dangerous earthquake hazards just as he has found.

I agree that a considerable number of them are obsolete overcrowded, badly maintained, unworthy of the fire personnel of the Fire Department and a disgrace to the neighborhoods in which they stand and to the great City of San Francisco.

I also agree with many of his specific comments calling attention to various weaknesses in the individual groups,

particularly the large number of wall openings in front and rear walls of the older stations and the lack of ties between these walls and interior wood framing of the stations. Other weaknesses not particularly stressed in his report are, weaknesses of Hose Tower supports and of Apparatus Room Floors under greatly increased loadings.

Rot and termite damage appears to have been largely repaired since his report was written.

It does not follow, however, that all my recommendations for the treatment of individual Fire Stations will agree necessarily with his. Since few of these stations are subject to mathematical calculations our recommendations are to a very considerable degree a matter of judgment and will, therefore, at times be at variance. As a matter of fact I believe the general agreement in our recommendations for individual stations is rather remarkable.

My one exception to his general findings is with his statement that "Many of the stations went through the 1906 shock, and it is a certainty that while damage was evidently minor the nailing was loosened up. In another severe shock their behavior would be somewhat questionable with partial transverse collapse not at all out of the realm of possibility."

After a pretty thorough investigation I find no evidence of such weakening. ( See full discussion on pp. 27-30 hereof )and am therefore using the type of building which went through the

shock of April 18, 1906 successfully as a criterion for my recommendations in connection with such of them as still stand as well as those of similar construction built since 1906. Of course, many other facts and features have been considered, but their behavior in 1906 has been given considerable weight.

Based on this behavior largely, I have given my opinion that seven buildings, Engine House Nos. 15, 24, 42, 43, 46, 48 and Truck #2, can be permanently continued in use, and that three additional Engine House Nos. 33, 36, and 38, can be temporarily continued in use. Mr. Engle has included one of the above,Engine House #15 for immediate destruction; two of frame type, Engine Nos. 42 and 43 for "repair; the "replacement by a better type would be desirable;" four of the Class "C" type Engine Nos. 24, 46, 48 and Truck #2, in his "extremely hazardous to equipment and personnel" but "repair feasible" group. The three which I have recommended for temporary "continued use" he has included in his frame group of stations for condemnation, largely I believe for obsolescence and age, so that actually in the case of these three we are rather closely in accord. I have recommended them for temporary use because it is apparent that if either Report is accepted as the basis of a Reconstruction program all the stations cannot be removed at once and it will be necessary to continue a considerable portion of them in use for some time. I believe that these three old wooden stations are much safer today than some of our more modern ones.

My grouping under heading - "Abandon" - "Reconstruction" and "Continued Use" are listed in the Conclusions and tabulated in Table VII. This grouping is somewhat different from that of Mr. Engle's and therefore cannot be directly compared. It should be remembered that eleven years have passed since the Engle Report was written and that these eleven years have done the stations no good. Also, the weight of motorized equipment has steadily increased since that time and made the danger of floor collapse a very important factor in my rulings, whereas Mr. Engle's report dealt largely and primarily with earthquake risk. Also, I had one advantage over him. In my investigation I was able to cut the brick work of the various stations to ascertain the relative strength of this material, while he did not. The quality of this material is in general recognized by engineers as a major factor affecting the stability of brick buildings under seismic forces.

Since Mr. Engle's Report was written the Fire Department has abandoned or rebuilt three stations condemned by him - Truck #6 formerly located at 349 Herman Street; Engine #27 formerly at 52 Waller Street and Engine #32 near Holly Park - and will soon abandon and replace two others, Engine #10 and #29. Of these last two the first had been included by him for condemnation and the latter for Repair.

Since his Report four new Stations have been built. Engines #32, 35, 27 and 30 and are not covered by his report. Two of these - Engines #27 and #32 were two of the replacements mentioned in the preceeding paragraph.

As a crude comparison of our relative findings, it might be noted that he recommends for abandonment 15 stations (in addition to those abandoned since the time of his report) and advises the replacement by better types of 8 others and recommends reconstruction for 23 (Total 46), while for the same group I, after eleven years have passed, recommend abandonment of 24 (of which five, Engines #3, 12, 16, 20, 44 because reconstruction is thought economically unwarranted); Reconstruction of 12; and Continued Use (as is or with comparatively minor changes) of 11 (total 46). Of the last group 5 must have Apparatus Room Floor loads severely limited.

The stations in these groups are not entirely identical and only by a study of the individual recommendations can the reader obtain a true comparison. (See Appendix)

## SYNOPSIS OF CONCLUSIONS

THE ENGLE REPORT:

I agree with all the general findings of the Engle report with one exception. I cannot agree with his contention that because a fire house went through the 1906 earthquake it was so badly racked as to be dangerous in another similar quake. I have found no evidence of such racking. On the contrary, all evidence points to the fact that the frame stations in particular, as well as the interior wooden frames of the brick stations went through that earthquake undamaged by racking and that their interior framing is just as good as it ever was, as far as earthquake racking is concerned. This evidence indicates in my opinion that certain buildings that went through 1906 were "earthquake resistant." Therefore, I am rating buildings of similar construction as also"earthquake resistant."

Note:- Since no one can know just how violent an earthquake may become, no building can be rated as earthquake proof.

As to Mr. Engle's recommendation as to reconstruction of individual stations, would say that it is only natural our recommendations should not entirely agree since they are arrived at largely by judgment. None of these stations with

two or three exceptions have been designed in such a way as to be subject to mathematical analysis for lateral forces. In fact there is no evidence with the exceptions mentioned that any real analysis for lateral forces were ever made in their designs. In view of this I believe it rather remarkable that the recommendation for treatment of individual structures are as closely in agreement as they are.

FIRE CHIEF STANDARDS:

Chief Engineer Edward P. Walsh of the Fire Department, in conference with me, decided that as a matter of standards all fire station floors, if approved for permanent use, should be capable of supporting any piece of fire apparatus now in use. He also ruled that all dormitories must be considered to be crowded unless there is three feet in the clear between dormitory beds and finally, required them to be earthquake resistant and safe for personnel and against trapping of apparatus.

With all these rulings, I am in hearty agreement. However, since there are only four or five of our stations as they stand today which meet them all, the rigid enforcement of such standards would require such a complete reconstruction program as would be impossible at one time. This possibility was foreseen by the Director of Works who introduced into our contract the requirement that buildings listed for abandonment or reconstruction be separated into two groups.

1. Dangerous and emergency reconstruction projects, and

2. Less dangerous and subject to delay.

This is a difficult matter. Is the reconstruction of a weak and dangerous Apparatus Room Floor subject to more delay than a building which is in danger of complete collapse during a major earthquake? Is it more dangerous than a building which in a severe earthquake might partially collapse or whose front wall might fall and trap the fire apparatus? Such questions are difficult if not impossible to answer since a time element is involved.

Will the overloaded structure collapse next week or next year?

Will the earthquake come tomorrow or five years hence?

In an endeavor to introduce some elasticity into the reconstruction program I have in my Recommendations for individual stations (to be found in the Appendix hereof) recommended for "Reconstruction" or "Continued Use" certain stations whose apparatus room floors cannot economically be made safe for the 22,000 lb. maximum axle load of today's heaviest fire-fighting equipment. In each such case I have given the maximum allowable wheel load for the station. This rating may be for the present loads only or for a 7200 or 8850 lb. wheel load. The 7200 lb. wheel load qualified the station to take all present day apparatus except areal trucks and Fire Boat Hose Tenders - and the 8850 lb. rating qualifies the station to house all

apparatus but the two heavy Fire Boat Hose Tenders. Some time after the rest of the program has been completed it will be necessary to replace these stations (or at least their floors) to meet the Standard as properly set up by Chief Walsh.

SUMMARY OF INDIVIDUAL RECOMMENDATIONS:

I finally adopted group classifications:

1. Abandonment - Priority Rating Group I
2. Abandonment - Priority Rating Group II
3. Reconstruction - Priority Rating Group I
4. Reconstruction - Priority Rating Group II
5. Special Emergency Study
6. Continued Use (Possibly with Minor Alterations) - Standard Floor Loads
7. Continued Use (Possibly with Minor Alterations) Limited Floor Loads

I was forced to place one station in the fifth group as it required mathematical analysis beyond the scope of this report which when completed would probably throw it either into "Abandon" or "Continued Use." It, in my opinion, could not well fall into a Reconstruction Classification.

In "Abandonment Priority Group I" I am combining buildings with Apparatus Room Floors definitely in a dangerous condition under present loadings with buildings which in my opinion would be in danger of complete collapse in a severe earthquake.

In "Abandonment Priority Group II I am combining buildings with weak-floors, dangerous overloads, with buildings which in my opinion will be in danger of partial failure in a severe earthquake.

## TABLE VII

## SUMMARY OF RECOMMENDATIONS FOR FIRE HOUSE TREATMENT

| | | | |
|---|---|---|---|
| 1876 | Engine #14 | Abandon P.G. 1 | Abandon P.G. 1 |
| 1884 | Engine #11 | " " 2 | " " 2 |
| 1884 | Engine #13 | Abandon " 1 | " " 1 |
| 1884 | Engine #15 | Emergency Reconstruction | " " 1 |
| 1892 | Truck #11 | Abandon P.G. 2 | Reconstruction P.G. 1 |
| 1893 | Engine #21 | " " 1 | Abandon P.G. 1 |
| 1893 | Engine #23 | " " 2 | " " 1 |
| 1895 | Engine #10 | " " 2 | " " 1 |
| 1896 | Truck # 6 | Already Abandoned | - - - |
| 1896 | Engine #33 | Continue Use P.G. 2 | Abandon P.G. 1 |
| 1896 | Truck #12 | Abandon P.G. 1 | " " 1 |
| 1897 | Engine #34 | " " 1 | " " 1 |
| 1898 | Engine #22 | " " 1 | " " 2 |
| 1905 | Engine #36 | Continue in Use P.G. 2 | " " 1 |
| 1906 | Engine #38 | " " " " 2 | " " 1 |
| 1907 | Truck # 5 | Abandon P.G. 1 | " " 2 |
| 1908 | Engine # 7 | " " 2 | " " 2 |
| 1908 | Engine #31 | " " 2 | " " 1 |
| 1909 | Engine # 1 | " " 1 | Reconstruct P.G. 1 |
| 1909 | Engir # 2 | Emergency Reconstruction | " " 1 |
| 1910 | Engine #26 | Abandon P.G. 1 | " " 1 |
| 1910 | Engine #40 | " " 2 | Abandon P.G. 2 |
| 1910 | Engine #41 | " " 1 | Reconstruct P.G. 1 |
| 1910 | Engine #44 | " " 2 | Abandon P.G. 2 |
| 1911 | Engine #45 | " " 1 | Reconstruct P.G. 1 |
| 1912 | Engine #42 | Continue Use P.G. 1 | Abandon P.G. 2 |
| 1912 | Engine #43 | " " " 1 | " P.G. 2 |
| 1912 | Engine # 6 | " " Im. Study | |
| 1913 | Engine #46 | " " P.G. 1 | Reconstruct P.G. 1 |
| 1913 | Engi #28 | Rconstruct P.G. 2 | " " 1 |
| 1914 | Engine #24 | Continue Use P.G. 1 | " " 1 |
| 1915 | Engine #48 | " " " 1 | " " 1 |
| 1915 | Engine #18 | Reconstruct " 2 | " " 1 |
| 1915 | Engine # 9 | Continue Use " 2 | - - - |
| 1916 | Truck # 2 | " " I.M. Study | " " 1 |
| 1916 | Engine # 3 | Abandon P.G. 2 | " " 1 |
| 1916 | Engine #12 | " " 1 | " " 1 |
| 1917 | Engi # 8 | Reconstruct P.G. 2 | " " 1 |
| 1917 | Engine # 4 | " " 2 | " " 1 |
| 1918 | Engine #17 | " " 2 | " " 1 |
| 1918 | Engine #37 | " " 2 | " " 1 |
| 1923 | Engine #39 | Abandon P.G. 1 | " " 2 |

## TABLE VII

## SUMMARY OF RECOMMENDATIONS FOR

## FIRE HOUSE TREATMENT

(Continued)

| | | Vensano's | Engle's |
|---|---|---|---|
| 1925 | Truck # 1 | Continue Use-Im.Study | - - |
| 1926 | Engine #16 | Abandon P.G. 1 | Reconstruct P.G. 2 |
| 1927 | Engine #25 | Reconstruct Im. #2 | " " 2 |
| 1928 | Engine #19 | Reconstruct " #2 | " " 2 |
| 1928 | Engine #29 | Abandonment Ordered | " " 2 |
| 1928 | Engine #47 | Reconstruct P.G. 2 | " " 2 |
| 1931 | Engine #49 | Reconstruct P.G. 2 | " " 2 |
| 1938 | Engine #20 | Abandon P.G. 2 | " " 2 |
| 1939 | Engine #35 | Continue Use P.G. 1 | - - |
| 1940 | Bureau of Equipment | Continue Use-Im.Study | - - |
| 1942 | Engine #32 | Reconstruct - " " | - - |
| 1950 | Engine #27 | Continue Use P.G. 1 | - - |
| 1951 | Engine #30 | Continue Use P.G. 1 | - - |
| | Fire Boat #2 | Continue Use P.G. 2 | - - |

Note:- Definition of Abbreviations above:

P.G. 1 = Priority Group I

P.G. 2 = Priority Group II

I.M. Study = With Immediate Additional Study

I have included Engine #9 and Fire Boat #2 in Group #6. They are the property of the State Harbor Commission. They can be safely occupied - are overcrowded and obsolete and an insult to the personnel housed in them and should be rebuilt by the State or abandoned as soon as the reconstruction program permits.

I have eliminated the question of overcrowding and obsolescence of a station as a primary cause leading to a recommendation for abandonment. Overcrowding is controllable (possibly with great difficulty but is theoretically controllable) by re-assignment of personnel or construction of additional fire houses.

However, it will be found that a number of the most overcrowded stations have been recommended for other reasons for Abandonment.

In Groups I and II for Abandonment have been included a number, the reconstruction of which I have believed would be found economically unwarranted. These include Engine Nos. 3, 12, 16, 20 and 44.

In all cases where reconstruction is advised, full engineering studies and analyses together with preliminary plans and cost estimates should be obtained from competent licensed Structural Engineers. These should be authorized at once as they will require some time. Many dangerous situations exist in this group of stations and they should be corrected with all possible dispatch.

Undoubtedly the first question which will come to the mind of the Director of Public Works as well as to those of the Commission and Administrative staff of the Fire Department on reading this Report will be - what will be the cost of such a program? While I have little to go on, no one else has at present as much, so I must try and be helpful. Eleven years ago Mr. Engle who also had little to go on suggested a round figure of $1,000,000 for the cost of a somewhat similar program. Even at that time, in my opinion, that amount was insufficient. Since then inflation has done its work and today construction costs are about two and one-half times what they were in 1940.

I believe that $60,000 should be provided at once for the preliminary engineering studies and estimates recommended herein before; and that the entire reconstruction program will cost not less than $5,000,000.

Some stations will undoubtedly be combined into multi-company stations in any such program and the number of such combinations will effect the total cost.considerably one way or the other.

At one point in my discussion with Fire Chief Walsh I requested him to diagram such possibilities for the benefit of this report but after some discussion he properly pointed out that he could not intelligently do so until the finding of this report reached him and he would know which station would be listed for Abandonment.

RECONSTRUCTION STANDARDS:

Stations when Reconstructed should be brought to the full earthquake standards of the San Francisco Building Code of 1947. If this in any particular case is found to be impossible with the alternate, the condemnation and destruction of the Station, two-thirds of this standard might, in my opinion, be warranted. For Apparatus Room Floor reconstruction the full Standard 22,000 lb. axle load with wheel 6' 0" centers as fixed by Fire Chief Walsh should be provided for at stresses permitted by the 1947 Code.

It is my belief that all future fire stations should be built to fireproof Class 1-A or 1-B Standards as defined in the 1947 Code with concrete walls sufficiently thick to protect to some extent the fire house apparatus and personnel from bullets and bomb fragments.

(Note:- I am an optimist in that I do not believe that atomic bomb warfare as now visualized will ever be waged but I do think that war with the Communist world is in time not at all improbable and should be given some thought in this reconstruction program.)

No real idea of overall cost is obtainable until the Engineering studies for the proposed Reconstruction projects have been completed and a final and complete program of construction and reconstruction decided upon. Such program will in all probability require a minimum construction period of four years, even if the funds for preliminary studies and plans is at once forthcoming and there is no unreasonable delay in securing the funds for the entire project and no delay in the securing of property.

With the large number of stations presently in dangerous condition and the impossibility of clearing existing stations until new ones are built it would seem necessary to set up a program for the immediate construction of six to eight new fire houses on new property into which personnel and equipment from a similar number of old stations can be moved, thus starting a sort of chain reaction. Only in such fashion can I see how the entire program can be finished even in four or five years.

This entire situation should be considered an emergency matter. I agree with Harold Engle that in an earthquake of the severity of that of April 18, 1906, much of the fire apparatus might be trapped in their stations as they now stand. Many things can happen in four or five years even earthquakes.

At this point I would like to acknowledge my obligations to give my thanks to the officials, offices and men of the Fire Department for their willing and courteous assistance to me in this work.

I would like to thank in particular Chief Engineer, Edward P. Walsh, Chief Rudolph Schubert, Secretary of the Fire Department and Messrs. Harry Hansen, Superintendent and Mr. Walter Zecher, Assistant Superintendent of the Bureau of Building Inspection and Mr. F. Geaney-Gunman, all in the Department of Public Works of the City, for their courtesy and whole-hearted cooperation with me in this work.

To Lieutenant Gino Perra of the Fire Department goes the credit for the fine photographic work evidenced in the pictures of the Fire Stations attached to this report.

Respectfully submitted,

H. C. Vensano,
Consulting Structural Engineer,
License 262.

# A P P E N D I X

## DETAILED RECOMMENDATION

## FOR

## INDIVIDUAL FRAME STATIONS

Pages A-1 to A-17

Note:- It has been found impractical to include all my detailed notes on individual stations as a part of this report. Additional and more complete notes will be on record in my office. (H.C.V.)

# I N D E X

## TO

## FRAME STATIONS


| | | | |
|---|---|---|---|
| Engine | 7 | Page | A-12 |
| " | 9 | | B-19 |
| " | 10 | | A-2 |
| " | 11 | | A-1 |
| " | 14 | | A-1 |
| " | 21 | | A-3 |
| " | 22 | | A-8 |
| " | 23 | | A-4 |
| " | 31 | | A-13 |
| " | 32 | | B-41 |
| " | 33 | | A-5 |
| " | 34 | | A-7 |
| " | 36 | | A-9 |
| " | 38 | | A-10 |
| " | 40 | | A-14 |
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| " | 43 | | A-17 |
| " | 44 | | A-15 |
| Truck | 5 | | A-11 |
| | 6 | | A-2 |
| | 10 | | B-6 |
| | 12 | | A-6 |
| Fire Boat #2 | | | B-40 |

## RECOMMENDATIONS AS TO INDIVIDUAL STATIONS

Built in 1876 - Engine House #14 - Frame Construction.

Recommendations:- Building be abandoned and destroyed. Rated in the #1 Priority Group. It is immediately dangerous and has neither vertical nor lateral stability.

Natural foundations sand - "fair."

Apparatus Room Floor already temporarily strengthened is in a dangerous condition under its present light loadings. Some dry rot present. Open to termite infestation existing in foundation of building next door.

Lateral stability - none. Mezzanine Hayloft construction has been removed. Large but badly designed knees have been installed. They are of little, if any value. Building leans to the east.

Hose tower is still in place.

Building obsolete and somewhat overcrowded.

Maintenance - "poor."

Obsolete - Designed for horse drawn vehicles.

Built in 1884 - Engine House #11 - Frame type construction.

Recommendations:- Should come down, but not immediately dangerous. Priority rating #2 for abandonment. The building is long past its useful life and very much overcrowded. There are only 16 beds for 42 men.

If continued in use temporarily, the Apparatus Room floor girder under the truck side floor should be replaced with one of greater strength. It is now overloaded in shear. The building has some lateral stability. It is a twin type. The mezzanine floor is still in place. There is some termite infestation in front wall.

Hose tower has been removed.

Natural foundations are rated as good.

Maintenance entirely lacking, probably due to expected early replacement. Obsolete - designed for horse drawn equipment.

Built in 1895 - Engine House #10 - Frame type.

Recommendations:- Plans are now being drawn for a new station to replace this one, therefore complete investigation not made.

Natural foundations - "Poor."

This station is not immediately dangerous though it is obsolete and badly in need of maintenance and repair.

Would probably have been given an "Abandonment" Rating of Priority #2, i.e., might be used temporarily.

In much better shape than some other frame houses which should be first removed.

Apparatus Room floor unsafe under standard loads, but reasonably safe under present loads.

As a twin type Lateral Stability is "Fair." Mezzanine Floor still in place.

This building should be further investigated for rot and decay beneath first floor.

Maintenance "Poor." Not crowded, but short of toilet facilities - 2 toilets for 49 men.

Built in 1896 - Truck House #6 - Herman Street.

Recommendations:- This station has been abandoned and is no longer in use.

Built in 1893 - Engine House #21 - Frame type.

Recommendations:- Dangerous. Should be abandoned at once.

Rating Priority Group #1 for destruction.

Natural foundations sand - "Good."

Apparatus Room floors dangerous very weak under existing vertical loads. Squeaks and groans.

Laterally insecure Mezzanine floor has been removed and small and insufficient knees substituted.

Building leans to East.

Hose tower still in place.

Rustic siding has single thickness only.

Some rotting evidenced.

Nailing in attic space "poor."

Quarters crowded. Officers sleep in dormitory with men. A Battalion Chief's Headquarters.

Maintenance: "Poor" inside and out. Badly needs painting. Roof old and gives continuous trouble from leakage.

Reconstruction economically unwarranted.

Obsolete, designed for horsedrawn equipment.

Built in 1893 - Engine House #23 - Frame type.

Recommendations:- Should come down - Priority #2. May remain temporarily with minor reconstruction by limiting apparatus loads to those in Station at present (or of equivalent weight).

Natural Foundations are sand, rated "Good."

The building is dangerously weak for standard floor loads.

Also, against Lateral Forces as it now stands. Connections of knee braces in Apparatus Room should be improved and nailing increased. After such repair, the building may be used temporarily but should be replaced as soon as possible.

Mezzanine Floor has been removed, decreasing its lateral stability.

Outside walls of building are single sheathed.

Trussing in attic space has been damaged by fire and not fully repaired.

Hose Tower still in place - supports should be investigated and if necessary strengthened. Tower said to vibrate badly in the wind. There have been earlier efforts to strengthen it.

Maintenance "Poor."

Station not crowded.

Obsolete - designed for horse drawn vehicles.

Should be abandoned as soon as possible.

Built in 1896 - Engine House #33 - Frame type.

Recommendations:- Not immediately dangerous. May be temporarily continued in use after strengthening girder under Apparatus Room floor, which shows shear cracks. Possible stored equipment should be eliminated. Helps to overload girder.

During use of this building the Apparatus Room floor should be limited to use under present lighter types of apparatus only.

It is insufficiently strong to stand up under a standard wheel load of 8850 lbs.

Its Lateral stability is considered OK -- went through 1906.

The Mezzanine floor is still in place.

The hose stored on the Mezzanine floor should be removed and stored elsewhere as its deadweight adds to the destructive effect of lateral forces.

Hose Tower supports should be investigated and improved. There is complaint of vibration.

Nailing in the trussing of the attic space should be increased.

These improvements should be made immediately.

Maintenance is generally poor.

New lighting system needed.

The station is not overcrowded.

Natural foundations are sand and "Good."

Built in 1896 - Truck House #12 - Waller Street near Stanyan St.

Recommendations:- Dangerous - should be removed. Group I rating.

Natural Foundations "Good."

Apparatus Room is in danger under existing load.

Mezzanine Floor has been removed and the building is weak against lateral forces.

Knees have been substituted as a bracing element but are not properly connected. To be effective must improve their connections with studs and floor joists.

Attic space trussing is unscientifically designed, and without web members.

This building is very weak laterally.

Hose Tower has been removed and hose racks on roof substituted. These are located at center of roof spans and cause an overload of roof supports.

Single sheathed outside. T & G inside ceiling in 1st story only.

Quarters not crowded.

Maintenance "Poor." Obsolete type for horse drawn vehicles.

If building must be continued in use temporarily - larger girder should be installed and trussing in roof completed immediately.

Built in 1897 - Engine House #34 - Ellis Street near Gough Street.

Recommendations:- Dangerous. Must come down. Priority #1 Group.

Apparatus Room Floor is in dangerous condition under present loadings and has been badly rebuilt or stiffened on several occasions.

Mezzanine Floor has been removed and there is no lateral support for the building.

Dangerous in case of earthquake.

Hose Tower is still in place and needs bracing.

Large unscientific knees framed into station to afford lateral support have little value.

The station is overcrowded.

Natural Foundations clay or sand on Hillside - rated "Fair" to "Poor."

Not overcrowded.

Maintenance "Poor."

Obsolete - designed for Horse drawn vehicles.

Built in 1898 - Engine House #22 - Frame type.

Recommendations:- Dangerous - should be abandoned - Priority rating - Group #2.

May be temporarily used.

Natural Foundations sand "Good."

Apparatus Room Floor weak under a standard loading of 8850 lbs.

May be used temporarily under present loads.

Mezzanine Floor has been removed and the building has no stability against earthquakes.

Trussing in attic space very poor and of unscientific design.

Maintenance has been "very poor."

Station is not crowded.

Hose Tower is still in place. Its support should be investigated and strengthened if the building is to be maintained in use for any considerable time.

All sheet metal gone from front wall and these areas subject to leakages from rain.

Obsolete - designed for Horse Drawn Vehicles.

Built 1905 - Engine House #36 - Frame type for Horse Drawn Vehicles.

Recommendations:- Station is safe and may remain if Apparatus loads are limited as indicated below.

Natural Foundations "Good."

Apparatus Room Floor safe for 7200 lb. wheel load.

(Note:-This eliminates Areal Trucks and Fire Boat Hose Tenders.)

Went through Earthquake 1906 and is regarded as earthquake resistant.

Station is considered structurally safe under above loads.

Quarters very much overcrowded - 36 men in 29 beds - 6 officers have 4 beds - beds close up - 2 showers only.

No plans are available for this station. It should be remembered, however, that these early stations were designed to house only ten to twelve men who occupied them 24 hours per day.

Maintenance "Poor."

Hose Tower in place. Supports should be checked and strengthened if necessary.

Brick chimney should be removed above main roof level.

Front wall needs repair.

Unless overcrowding can be eliminated, building should be replaced.

Built in 1906 - Engine House #38 - Frame - Horse Drawn Type.

Recommendations:- Can be salvaged. A reconstruction project.

Natural Foundations sand,"Good."

The Apparatus Room Floor is OK for standard wheel load of 8850 pounds. (Not for Fire Boat Hose Tenders.)

It is considered earthquake resistant, as it was tested and came through the earthquake of 1906 without damage. Mezzanine and Hay-loft still in place. But further check of attic space trussing (with increased nailing) and crude hose tower support should be under-taken because of statements by firemen that the building vibrates in wind. Such vibra-tion might be caused by undiscovered dry rot or termites.

Brick chminey now extending beyond the roof level should be removed.

Front wall is in bad shape with top railing and ornaments ready to fall off.

Building can be materially stiffened by rebuilding of front wall and removing second story bay window.

Nailing of knee braces should be increased and connection to building frame improved. Knee braces now at 32"-centers intermediate knees should be installed.

The station is overcrowded - 27 men in 22 beds; 2 toilets only, one on each floor. 3 Battalion Chiefs in 2 beds.

Outside maintenance has been "very poor."

Maintenance - "Fairly Good" inside.

No plans available - probably designed to house 10 to 12 men.

Built in 1907 - Truck House #5 - Frame Type for Horse Drawn Vehicles.

Recommendations:- Dangerous - must be abandoned. Priority Rating #1 Group.

Natural Foundations - sand over rock "Good."

Apparatus Room Floor very much overloaded under present loads.

The Mezzanine Floor has been removed and the station is not well braced for lateral loads. This condition may be improved by strengthening the connections of the knee braces which were substituted for the Mezzanine Floor.

The station is crowded - 27 men in 24 beds.

Maintenance has been very poor - appearance disreputable.

Lighting system is bad.

There is also trouble with the hot water piping.

The roofing is in bad condition and subject to continuous repairs.

The wooden trim is coming off of the front of the building.

Rot inside walls.

Obsolete.

Built in 1908 - Engine House #7 - Frame - Horse Drawn Type.

Recommendations:- Dangerous under earthquake conditions.

Down priority - Group #2.

Apparatus Floor "Good" for 7200 lbs. wheel load. This eliminates areal trucks and heavy hose tenders.

There are no provisions for lateral forces.

Mezzanine Floor has been removed.

There are no knees. Only one large glass partition in first story.

Many openings exist in front wall.

Quarters crowded - 24 men in 21 beds; designed for 14 men.

Maintenance needed. Believe it uneconomical to attempt to salvage this building.

Hose Tower in place.

Built in 1908 - Engine House #31 - Frame - Horse Drawn Type.

Recommendations:- Dangerous. Should be abandoned. Priority Group II.

Natural Foundations is rated "Fair" to "Poor" in sandy clay over rock, but on a side hill.

Apparatus Room Floor is supported on studs and is dangerous and unstable.

Mezzanine Floor has been removed and the building has no bracing against lateral forces and is therefore in serious danger of collapse in any major earthquake.

Some poorly connected knee braces with weak nailing have been introduced. These could be strengthened but there is no bracing in attic space.

The roof is poorly designed structurally.

Roof trussing offers no lateral support since it is of ridged type with 1 x 6 compression numbers.

Front wall is full of openings.

Building is said to creak and rock in heavy winds.

Reconstruction is economically unwarranted. Hose Tower still in place.

Slate Roof should be removed from Hose Tower and Mansard Front roof.

Brick chimney if still in place should be removed.

The quarters are not overcrowded.

Outside maintenance "very poor."

Obsolete and dangerous.

Built 1910 - Engine House #40 - Frame Horse Drawn Type.

Recommendations:- Structurally unsafe both for Standard Vertical and Lateral Loads. Should be abandoned. Rated Priority Group #2.

Natural Foundations. Probably shale, rated "Good."

Apparatus Room Floor too light for standard loads. Loads must be limited to present light loads while still in use.

Is a dangerous earthquake risk at present. The Mezzanine Floor is still in place. Outside stucco has many cracks, apparently caused by vibration under lateral forces. Roof trussing is highly unscientific and is weak vertically and adds nothing to lateral rigidity. Siding - stucco over 1 layer of sheathing. Inside sealing - plaster.

Quarters somewhat crowded - Station designed for 10 beds - now contains 18 beds for 20 men. Three men are from Ashbury Tank (Across the Street) Station.

No underground Gasoline Storage.

Maintenance "Good" has just been completely painted.

Reconstruction not deemed economically feasible.

Built in 1910 - Engine House #44 - Frame,Horse Drawn Type.

Recommendations:- Dangerous. Should come down. Rating Priority Group #2.

Weak under lateral forces - May remain temporarily.

Natural Foundations rated "Good" - probably red rock.

Apparatus Room Floor originally of frame construction was replaced by W.P.A. with earth fill and is now safe.

Building is dangerous from earthquake viewpoint.

Mezzanine Floor is still in place, but the roof trussing is entirely unscientific and offers no lateral support; has been temporarily braced against wind.

Building is plastered inside and has many openings in front and rear wall. Extensive repairs of termite damage made in past.

This front portion of the roof structure is at present unstable and should be replaced immediately.

The only reason for rating this weak structure in Priority Group II for demolition is its good Natural Foundation.

Terra Cotta tile on front Mansard roof must be immediately removed as a definite earthquake hazard. It is directly over the entrance and improperly supported by weak roof construction. Terra cotta tile roof on Hose Tower should be removed.

A considerable section of metal lath and plastered ceiling recently fell in the dormitory (More may be unsafe). Fortunately, this happened when no one was in the dormitory or some one would very likely have been killed.

Quarters not crowded.

No subsurface Gasoline Storage - 1-50 gal. buggy only.

Maintenance - "Poor" at time of my survey but since painted outside.

Built in 1912 - Engine House #42 - Frame - Horse Drawn type.

Recommendations:- Believe this building can be allowed to stand with improved nailing in attic trussing and investigation, and if necessary strengthening of Hose Tower supports.

Natural Foundations are probably sand or sandy clay and rated as "Good" since the ground is level.

Apparatus Room Floor is largely (42') on the ground with small rear portion on a reinforced concrete floor construction. Apparatus Room Floor is safe under all loads if kept on front portion which is not only possible, but probable under ordinary operation. The rear portion should be limited to maximum wheel loads of 7200 lbs. This is present loading.

Station is rated as earthquake resistant since the Mezzanine Floor is still in place and buildings of this type safely passed through the quake of 1906. Also, small knees.

Double sheathed outside - is finished inside throughout with 7/8" T & G ceiling.

Quarters are not crowded. Housing 15 men in 15 beds. Designed for 10 beds.

Terra Cotta Tile should be removed from the Mansard roof in the front of the building. It is dangerous in case of quakes.

Nailing of trussing in the attic space is "Fairly good" but advise strengthening by doubling the nailing.

Hose Tower is standing and supports should be checked.

Maintenance "Fair" to "Poor" at time of inspection. Has been painted since I believe.

Built in 1912 - Engine House #43 - Frame Horse Drawn type.

Recommendations:- This house may remain - Rated safe - not overcrowded.

Natural Foundations - rated "Good."

Apparatus Room Floor is supported directly on the ground for 44' frame front with reinforced concrete floor supporting balance of area.

It is safe under standard 8800 lb. wheel loads.

Mezzanine Floor still in place and building rated as "earthquake resistant." This type safely passed through 1906.

Small knee braces have also been added.

It is double sheathed outside. Inside finish throughout 7/8" T & G.

Quarters are not crowded. 15 men - 15 beds. Original design - 10 beds.

Maintenance is good.

It has been recently painted.

Nailing in attic space should be checked and could be increased to advantage by double nailing.

Hose Tower still in place - check supports.

Remove Terra Cotta Roofing detail over front awning. It is dangerous.

The yard paving is in poor condition and open shed in the yard is rotting away. These features should be reconditioned.

# A P P E N D I X

## DETAILED RECOMMENDATIONS

## FOR

## INDIVIDUAL BRICK OR CONCRETE STATIONS

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# I N D E X

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## BRICK OR CONCRETE STATIONS


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Built 1884 - Engine House #13 - Type "C" Group I - Designed for Horse Drawn Vehicles.

Recommendations:- Very dangerous - Condemn and "Abandon" - Priority Group I.

Natural Foundations "Poor."

Apparatus Room Floor in bad shape with some dry rot at joist ends.

Brick work "very poor." Partially collapsed in 1906.

Quarters for the men are crowded and unsatisfactory.

Inside maintenance "Fair" but doors and windows in bad shape due to lack of outside paint.

Built in 1884 - Engine House #15 - Type "C" - Group I - Designed for Horse Drawn Vehicles.

Recommendations:- Continued use but a Reconstruction Project to the extent that the first floor must be entirely rebuilt. This floor is in dangerous condition and has been repeatedly propped up. Emergency Rating - Balance of Building OK as is.

Natural Foundations "Good."

Brickwork - Excellent but not as hard as some rated "A."

Lateral stability "Good" and rated "Earthquake Resistant" and is believed to be satisfactory to resist an earthquake of the strength of 1906 since it passed through that one without damage. Can be left without change.

In reconstructing the first floor it should be designed for an axle load of 22,000 pounds with wheels at 6' centers. Condition of retaining wall at rear of lot should be investigated and if necessary repaired to prevent leakage of ground water through it.

Hose Tower still in place.

Quarters very much overcrowded - Beds are tight together and must be shifted to enter - Battalion Head quarters 24 men in 21 beds.

Lighting could be improved.

Maintenance "Fair."

Roofing should be replaced - many leaks. Some dry rot or termites in interior rear wall woodwork.

Built 1909 - Engine #1 - Type - Class "C" - Group I - Horse Drawn design. Front Wall of Stone with Brick backing.

Recommendations:- Building should be condemned and abandoned, largely because of "Poor" grade of brickwork with many openings in front and rear walls. Combined with probably Questionable Natural Foundations - Rated "Condemn and Abandon" in Priority Group (1).

Natural Foundations probably clay - rated "Fair to "Poor."

Location near original shoreline of Bay - Water is seeping into basement continually from many cracks in basement floor.

Apparatus Room floor as originally designed was of frame construction which would not meet the requirements of our Standard loads. A small "hole" drilled through the present concrete floors seems to indicate that this has been removed and subfloor space filled and concreted over. This should be confirmed if building is not to be abandoned. Some dry rot exists in first floor joist over basement area.

Unsafe for Lateral Loads - Mezzanine Hayloft has been removed. No interior bracing - "Poor" brickwork makes it very dangerous in a severe earthquake. Pieces now said to be falling off stone cornice from time to time. Hose Tower still in place - said to "vibrate and wobble" when hose is hung. Hose Racks added on roof and carry heavy size hose trussed Roof Rafters - probably overloaded - should be further investigated if Building is not abandoned.

Heavy stone ornaments overhang main doorway and could trap apparatus in a severe shock. Heavy overhanging stone cornice.

Quarters somewhat crowded.

Lighting "Poor" especially in first story.

Maintenance "Fair."

Built in 1909 - Engine #2 - Type Class "C" - Group I - Horse Drawn Design.
Front Wall Stone with Brick Backing.
Rated as an Emergency Reconstruction Project.

Recommendations:- Front and Rear walls must certainly come down and be rebuilt.
Front wall is believed in a dangerous condition and emergency action should be taken. There are two open cracks - one in each fire-wall buttresses at each corner of the front wall at its top. These indicate to me a tendency for the front fire wall and the heavy stone cornice to tip into the street. Should be immediately investigated with precision instruments for tilt.

Natural foundations - sand on slope, rated "Fair."

Apparatus Room floor would be unsafe under a standard 8850 lb. wheel loading and is therefore unsatisfactory. Wheel loadings must be kept down to 7200 lbs. if the station is to be kept in use. Some dry rot at location of former hose stalls. Entire floor should be replaced to care for standard loads. Unsafe for Lateral Forces as it now stands. By rebuilding front and rear walls with more limited openings and at the same time designing end connections of floors to front and rear walls to make the floors safe as horizontal diaphragms - this weakness may be corrected.

Brick work has been rated "Good, but Weak" and low unit stresses must be used for the brick work in Lateral Force Calculations.

Hose Tower supports are overloaded.

Not overcrowded - 24 men and 24 beds.

Outside Maintenance "Poor."

Building is obsolete - Was designed for Horse drawn vehicles. The above outlined reconstruction of front and rear walls and first floor may be found to be uneconomical when measured against the values remaining in this old structure, although I do not believe so or would have rated it for "Abandonment." Because all buildings cannot be simultaneously abandoned, am rating this as an "Emergency" Reconstruction Project for immediate investigation.

Built in 1910. West Section of Truck #11 - Type "C" - Group I Horse Drawn Design.
Front Wall has stone lintels.

Recommendations:- Dangerous - Abandon - Priority Group I.

West Section is dangerous and should be immediately abandoned. Foundations are wet clay. Apparatus room floor is gone from overloads and rot and is immediately dangerous. Brick work is rated "Poor" and "Weak."

Hose Tower is badly supported and building a hazard in a severe Earthquake. East Section is better. Apparatus Room floor is ground supported and brick work is rated "Good." This raises a problem as to whether this should not be rated as in the Reconstruction Class but the common or party wall between the two sections was originally a part of the west section and is therefore presumably of as poor brick work as the west wall in which our test was made.

Mezzanine floors are still in place in both sections. Nailing of roof trussing "Fair" to "Poor."

Maintenance is "Very Poor."

Yard structure in the rear is partly gone from rot and termites. Showers in bad shape.

Basement is continuously wet with water flowing across it from side hill spring.

Because of the unsafe condition of the Apparatus Room Floor - immediate action is necessary.

Believe a reconstruction of this Station is not economically warranted.

Built in 1910 and 1935. Engine #26 - A Twin House of Class "C" Group I type.
Original West Section of Horse Drawn Design.
East Section designed for Motor Vehicles.

Recommendations:- West Section including division wall is rated for "Abandonment." Priority Group #I, and I do not see how the East Frame Section with Brick Veneer on Front wall can be salvaged. This recommendation is made chiefly because of its very "Poor" brick work.

Natural Foundations "Fair to Good."

Apparatus Floor not good for Standard 8850 lb. load. Should be limited to 7200 lb. wheel load. About that at present.

East side wall of East Section a wooden stub wall carries the ends of the joists. This is a poor support for our heavy motorized modern equipment.

Poor brick work rules out any lateral stability. East upper corner of Front Wall was in danger of falling into street at time of my visit. It had completely cracked off due to expansion of metal channel irons, supporting the flag pole. Immediate attention was advised.

Station badly overcrowded - 30 men - 25 beds; with a poor and obsolete lighting system - 6 officers - 5 beds.

Outside maintenance "Very Poor."

Inside maintenance "Fair" but windows badly in need of paint.

Dangerous heavy stone cornice and other ornaments overhang the front wall and entrance. Brick veneer on front wall of east section is also a danger and should be removed.

Mezzanine Hayloft has been removed.

Built in 1910 - Engine #41. Type - Class "C" - Group I - Horse Drawn Design.
Front wall brick and Terra Cotta.
Apparatus Room Floor Reinforced Concrete.

Recommendations:- Should be condemned and Abandoned - Priority Group I - Brick work rated "Poor" - Terra Cotta cornice and ornaments overhang front wall and entrance. Floor overloaded. Station very crowded and obsolete in many features. Anchorage of Terra Cotta uncertain.

Natural Foundations "Fair."

Apparatus Room Floor is overloaded under our subnormal 8850 lb. Standard Wheel Load. But shows no cracks or weakness present conditions.

No lateral stability in view of "Poor" Brick work - Many openings in front and rear walls. Terra Cotta probably poorly anchored. Plans show no details. Roof is badly sagged at one point, possibly due to weight of hose tower.

Hose Tower still in place - Roof leaks in many places. I believe this water may enter attic space through rusted sheet metal work at top of Hose Tower.

An outside wood platform carrying an oil storage shed in the rear of the Station is a fire hazard.

Sewage from Kitchen runs into open sump in the rear yards. Sump Pump does not work properly - Stench and nuisance result.

Quarters crowded. Designed for 13 beds. Now 24 men and 22 beds. There are but 2 wash basins and 1 toilet for the men (exclusive of officers.) This is headquarters for 3 Battalion chiefs. No underground gasoline storage is provided. Kitchen in basement and sink drains into yard sump which gives out odor and is a public nuisance. This is just outside kitchen window. There is a shortage of lockers in the Dormitory. Heating said to be insufficient in parts of Building. No space for office work by officers or Battalion Chiefs.

Outside Maintenance "Poor." Needs new roofing and painting.

Cartonche over front entrance and terra cotta at top of front fire wall should be immediately removed.

Built in 1911 - Engine #45 - Type Class "C" - Group II - Horse Drawn Design.
Front Wall of Brick with Mansard Roof covered with Terra Cotta Roofing Tile above it.

Recommendations:- Abandon - Priority Group #1.
Because of "Poor" quality Rating of Brick work Apparatus Room Floor unable to take standard loads (8850 lb. wheel concentration).

Mansard Roof tile over Front Wall should be immediately removed. It is dangerous.

Natural Foundations sand - rated "Good."

Apparatus Floor - I could not inspect condition of Apparatus Roof floor from under side due to presence of plastered hung ceiling. It shows no evidence of weakness from above. However, mathematical calculations show it seriously overloaded under its present rather light loading and would be dangerously overloaded by our subnormal standard loading of 8850 lbs. per wheel.

Lateral stability is non-existant due to its poor brick work.

Mezzanine floor is still in place.

Hose Tower is still in place.

Many openings in Front and Rear Walls.

Quarters are not crowded.

Lighting is not good.

No subsurface gasoline storage.

Maintenance "Poor" - Exterior walls leak into Dormitory & Stair Hall, shown by peeling of paint on plaster in these areas.

Wooden building in yard houses Kitchen-Lunch Room Skylight leaks. Roof leaks.

Dry rot in Yard Fence.

Built in 1912 - Engine #6 - Type "B" - Group VI - For Horse Drawn vehicles - Reinforced Concrete throughout.

Recommendations:- Recheck entire design for its ability to withstand a subnormal standard axle load of 17,700 lbs. with wheel gage 6' 0" and for resistance to lateral forces based on coefficients two-thirds of the value of those required by the San Francisco Building Code of 1947. This study should be made by a competent Licensed Structural Engineer.

Terra Cotta Roofing tile ornamentation front wall over entrances should be removed - is dangerous.

Natural Foundations "Poor" building is on piles.

Apparatus Room floor probably heavily overloaded by 12" Rock fill and secondary 4" concrete wearing surface, together with its motorized equipment loads. The motorized equipment at present housed in this building is lighter than the standard set up in this report which can come into it at any time. It should be remembered that in 1912 concrete did not test to the strength of that today.

Lateral Forces:- Probably no special provisions for lateral forces made in its original design. Inherent factors of strength in a low (2-story and Hose Tower) building of "B" type may, however, prove to be sufficient to warrant its continued use.

However, other factors mitigate against its continued use. It is much overcrowded - 39 men in 24 beds, with total number of toilets 2 - One upstairs and one downstairs. There are but 2 showers and 3 wash basis in the entire station. Number of lockers correspond to the number of beds, i.e., 24.

Kitchen-Lunchroom facilities are inadequate for the 13-man shift.

Lighting System is inadequate - Obsolete on first floor in particular - consisting of open lights.

Maintenance is "Poor." Windows and doors need painting badly. There are cockroaches in the kitchen with a few from time to time said to be in the upstairs dormitories. These are said to have been brought in on the clothing of the Salvage Corp.

Condition of wood flooring in second story indicates that the sleepers are rotting out.

Built in 1913. Engine House #46 - Type "C" - Group I - Designed for Motorized Equipment. Front Wall - Brick with many openings.

Recommendations:- "Continued Use" with some comparatively minor Reconstruction. Front and rear walls have many openings. In the rear wall at least 2 openings in each floor in each section of the building must be closed (i.e. 4 in all) and at least three of the small openings in the first story of the front wall (all four would be preferable using a jib door in one of the main entrance doors as a man way entrance) This should be done with properly toothed-in brick work.

Terra Cotta Roof Tile on Mansard roof of front wall should be removed. It would be dangerous in a quake. The trussing in the attic space at the rear of the building is incomplete. This should be completed by the addition of necessary web members.

Natural Foundation sand - "Good."

Apparatus Room Floor is ground supported for a depth of 43' back of which is a reinforced concrete floor which seems to be in perfect condition under present loads. OK for Standard wheel loads (11,000 lbs.) if on ground support. Girders in rear are also OK but floor slab in reinforced concrete section is but 4½" thick in this our maximum wheel load should be limited to 7200 pounds.

Lateral Stability - Natural foundations "Good." Brick work is similar in construction to Engine House #15 (which went through 1906 uninjured) except that it is a twin station with three longitudinal walls, one of which the middle or "party" wall being 21" thick increases its lateral strength proportionally over that of Engine #15. I am, therefore, rating it "Lateral Resistant" subject to the filling in of windows in front and rear wall as described above. There are partitions at both ends in the second story. There is no Hose Tower in this Station.

Engine House #46 - (Continued)

Recommendations:- Quarters are not crowded - 27 men - 27 beds.

Maintenance was very poor indeed at the time of my inspection. Notes as "Worst seen yet." Windows and doors had remained unpainted for so long that sashes were coming to pieces. Rot had begun inside of station in second story due to leakage around the shrunken window frames and chair rail. At one point was so far gone that it came to pieces in my fingers. Wood furring strips behind plaster were also rotting. Roof had been in disrepair and there was still leakage at flashings.

Sheet Metal work of skylights. Metal Vent Pipes were going to pieces from rust for long lack of painting as were the metal area grilles in the back yard.

Since my inspection, contract for maintenance has been authorized.

Built in 1913 - Engine #28. Type Class "C" - Group II - Designed for Motorized Equipment. Twin Station - Front wall double arched. Cathedral type. Believed dangerous in an earthquake.

Recommendations:- A Reconstruction Project after full engineering study by a competent licensed Structural Engineer, while I have little doubt that both the front and rear walls of this station would as it now stands be dangerous in an earthquake. I am rating it for Study and Reconstruction, if such study and preliminary planning show it economically desirable. Roofing Terra Cotta tile on front wall parapet should be removed.

The natural foundations are I believe on rock and therefore rated "Good" and the brick work has been rated "Fairly Good."

Front part of Apparatus Room Floor is ground supported. Rear portion is carried on structural steel and concrete construction. Good for 11,000 lb. Standard Wheel load. Roof trussing is overloaded by hose racks-should be investigated and strengthened if necessary. This would not be a major operation.

Lateral stability very questionable Front and Rear walls are pierced by many openings and I believe will have to be rebuilt. All walls have bond iron bonding at 1/2 first story height as well as at floor and roof levels. Brick work should be further tested by additional cutting of test openings.

Second Floor has 2 layers of wood flooring and might be considered for development as a Horizontal diaphragm.

The second floor joists in thi station are discontinuous between girders and run longitudinally of station instead of transversely. This, I believe, makes for more difficult reconstruction against lateral forces.

Quarters somewhat crowded - 24 men - 22 beds - 20 lockers. Kitchen-Lunch space in basement. No ventilation.

Lighting - "Poor" only 2 small lights for entire dormitory. Wiring system said to be overloaded - Open lights in officers' quarters "very bad."

No hopper for mop work - No janitor's closet - Mops and buckets kept on area roof in lightwell. Need "turn out" lockers in Apparatus Room.

Maintenance "Fair" - about time for exterior paint job.

Built in 1914 - Engine #24 - Type Class "C" - Group I

Recommendations:- Continued Use - with Minor repairs and alterations. Rebuilt upper portion of rear wall where rusting lintels have separated this top section of the wall from the part below. This is very dangerous in case of an earthquake - and should be considered an emergency repair.

Close small toilet room window opening in first story or rear wall by a toothed-in job. of brick work. An opening can be made in side wall instead. Double the nailing of web members and complete trussing where now incomplete in the attic space. Remove all Terra Cotta Tile from top of firewalls. Repaint Exterior and repair Roofing. Might be advisable to chip off projecting on Ornamental Arch about Main Entrace. Correct seepage into Basement. Improve Lighting System.

Brick work is rated A-1 or excellent and in extra hard and strong with joints fully filled.

Natural Foundations rated "Good" - probably shale.

Apparatus Room Floor is ground supported throughout and safe for full Standard 11,500 lb. wheel load.

Lateral Forces-this station is similar to Engine House #15 - is of excellent brickwork on a good foundation. I rate it as "Earthquake Resistant" after minor alterations specified above. South wall is unusually thick being 21" (north is 17 an added safety factor).

Quarters - not overcrowded - 15 men - 15 beds.

Kitchen Facilities small and poorly located under sidewalk - Lighting "Poor"- Open lights.

Exterior Maintenance i the past has been "very poor" with the result that rusting of steel lintels above second story rear wall windows has split and separated the top portion of this wall from the west of the building. This must be corrected - Some action taking place in a starting way in opening in north wall at sidewalk level. Sheet metal skylights, ventilator pipes and hoods and other outside sheet metal will be gone from rust due to lack of paint over a long period. For the same reason windows rattle and squeak. Roof is in bad shape with several large high blisters. No leads at present. There is a continuous stream of seepage into and out of the small basement. Yard buildings are of wood - a fire hazard.

Built 1915 - Engine #48 - Type "C" - Group I - A Corner Building with two street walls of Brick and Terra Cotta.

Recommendations:- "Continued Use" as is.

This building is heavily ornamented with Architectural Terra Cotta on its two fronts. I may be criticized for not recommending the removal of the terra cotta cornice and other terra cotta ornaments between the windows of the front wall. But the architectural plans show in detail special and better than average anchorage for the terra cotta materials. I believe it safe to assume that this anchorage is in place as shown. (I have been, of course, unable to check it. To do so would ruin the work.)

In addition, this building is undoubtedly founded on rock which is exposed above street grade on the opposite side of the street and has been constructed of brick work rated A-1 or excellent. It is of similar design to Engine House #15 which passed through 1906. It has one on the north side wall of greater than usual thickness, being 21" thick, in first story, 17" above. This station may have been designed in anticipation of future expansion as a twin station, with this as a dividing wall. There are less than usual number of openings in front and rear walls. The terra cotta ornamentation can, of course, be removed after all other more pressing work is completed, if you wish.

Natural Foundation - Rock - "Good."

Front 46' of Apparatus Room Floor is ground supported - Balance 6" reinforced concrete slab on steel supports. Safe for pull - standard 11,000 lb. wheel loading.

Lateral Forces - Rated as earthquake resistant for reasons given above.

Quarters not crowded - 12 men - 15 beds.

Kitchen in wooden building in the yard. Fire Hose racks in wooden shed in yard. These are a fire risk and might be lost in an incendiary bombing of the city.

Maintenance - "Fair."

Built in 1915 - Engine #18 - Type "C" - Group I - Designed for Horse Drawn Vehicles. Front Wall Brick and Terra Cotta.

Recommendations:- A Reconstruction Project for full study and analysis by a competent licensed Structural Engineer - Believe economically warranted while the red brick work of this station seemed to be the best and hardest of all brick work tested in any station. The face brick in the south wall seems about ready to drop off the building. The original mortar used with this face brick was soft, the joints very badly filled and weathering has cut back the already "raked" joints until this portion of the brick work is dangerous.

I believe it will be necessary to entirely remove and replace all face brick work at the same time the ornamental terra cotta overhanging cornice and other architectural terra are removed. The condition of the face brick work throws its condition and anchorage into doubt.

Natural Foundations - probably clay and "Fair."

Front 45' of Apparatus Room Floor is ground supported. Rear portion on concrete slab carried by steel beams and girders should be checked for Standard 11,000 lb. wheel load. Looks and acts OK under present loadings - shows no cracks.

Data on first floor slab and supports does not show on plans.

Lateral Forces - this station too has one brick side wall 17" thick in first story and 13" thick in the second, while the other is 21" thick in the front and 17" thick in the second. It was probably designed for extension to twin size later. It is of same general design as Engine #15 which passed safely through 1906. Red brick work is rated "Good" was the hardest brick work found by our tests, but had a few partially open joints on its interior. South wall face brick rated "Very Poor." All brick work should be further investigated. Front and rear walls have fewer openings than most stations.

Engine #18 - (Continued)

Recommendations:- Quarters not crowded.

Dry rot in window casings.

Lighting could be improved, especially in Apparatus Room.

Maintenance "Poor." Needs immediate care - outside windows going to pieces. Sheet metal work of skylights, vent pipes and hoods, etc. rusting badly. Does not seem to have been painted for a long time.

Yard structures are of wood - a fire hazard.

Seems to be dry rot under floor of Communication Room.

Built in 1916 - Truck House #2 - Type "C" - Group II - Three Part House.

Recommendations:- Complete Engineering Study and Analysis by competent Licensed Structural Engineer is recommended. I believe may be OK as is after removal of Terra Cotta Roofing tile from top of firewalls. But front wall is full of openings and building should be analyzed for Lateral Forces in all its parts. It may be necessary to rebuild front wall and alter roof and floor connections to walls to make them act as horizontal diaphragms.

Natural Foundations "Fair to Good."

Apparatus Room Floor appears to be OK under present rather heavy loads. Girders and beams are undoubtedly able to support full Standard 11,000 lb. wheel loads. The reinforcement in the 6" concrete floor slab itself is not shown on the plans. This should be ascertained and this feature of the floor checked against the requirement of 11,000 lb wheel load.

Resistance to Lateral Forces is uncertain until full study can be made. But brick work is rated "Excellent" or "A-1" with brick hard, mortar hard and joints well filled with mortar. Partial steel frame without exterior wall columns concentrates heavy loads on side and end bearing walls with no provision to take lateral forces. This makes for uncertainty and requires more mathematical investigation than can be given in this report.

Quarters are overcrowded - Designed for 25 men. Now 38 men - 38 beds.

Exterior Maintenance "Poor."

Windows and doors need outside painting badly. Also all exterior sheet metal work. Walls of stairwell tower need damp-proofing. Paint in this stairwell is peeling from the plaster at several points apparently from dampness coming in through south brick wall.

Front firewall is heavy on top and probably should be tied back to roof.

Built in 1916 - Engine #3 - Type "C" - Group III - (Twin House) Front Wall - Brick, Stone and Terra Cotta - Light steel frame with 13" thick sidewalls.

Recommendations:- I am rating this in the "Reconstruction" Group but believe after complete engineering study it will be found unwarranted economically. Front wall must be rebuilt, I believe. Lot - small. Station seems much too small. 39 men in 28 beds and 2 showers for 33 men. Kitchen facilities are diminutive.

Remove coping Terra Cotta Tile on Front wall.

Natural Foundations sand - "Good."

Apparatus Room floor is on ground and good for full Standard 11,000 lb. wheel loads.

Laterally unstable with very light columns in its steel frame - brick work is "Good." Reconstruction to resist lateral forces is possible, but will be expensive.

Hose Racks on roof - Attic Space trussing may be overloaded.

Lighting System not good and probably illegal.

Maintenance - Exterior Maintenance "Poor." Needs complete paint job. Outside kitchen wall is being lifted and split by rusting lintels.

Built in 1915 - Engine #9 - Property of State Harbor Commission - and Fire Boat #1 - Frame Type on Bulkhead Wharf

Recommendations:- This station seems to be safe for present Apparatus Loads and I believe is earthquake resistant, but it is entirely inadequate for the personnel using it. The crews of Fire Boat #1 and Engine #9, a total of 51 men, are housed in it. It is completely obsolete in its plumbing & lighting systems and fixtures. It should be abandoned as soon as possible in fairness to the men who must occupy it.

Terra Cotta Roof Tile should be immediately removed.

The station is the property of the State Harbor Commission.

Natural Foundations on a piled wharf.

Apparatus Room Floor OK, but floor spaced very much cramped and small.

Lateral Stability believed sufficient. But Terra Cotta Tile Roofing is an earthquake hazard and should be replaced with other materials. It is of all frame and stucco construction with wood sheathing behind stucco and sealed inside with T & G - O.P in both story walls and ceilings, except inside Apparatus Room which is plastered.

Quarters - very much overcrowded - 48 men in 43 beds. Station designed for 25. Only 2 showers and 2 bath tubs - 5 toilets but obsolete type.

Maintenance - "Poor."

At my request the Assistant Engineer of the Harbor Commission arranged for an inspection of the wharf which supports this station from beneath. He assures me it is in safe condition.

Note:- The Fire Boat pier is definitely in poor condition with floor plank rotted through in several spots and therefore "dangerous." Piling beneath not in very good condition. Wharf structures badly in need of paint. Food lockers under pier shed are of wood and are rat infested - Metal lockers should be supplied.

Built in 1916 - Engine #12 - Type: "Class C" - Group II - Triple Sections Brick and Terra Cotta - Street Walls.

Recommendations:- "Abandonment" - Foundations - "Poor." Wood Piles in Bay Mud - Brick work "Very Poor" - many open joints. No lateral stability. Many heavy architectural Terra Cotta ornaments and Terra Cotta overhanging cornices over Street Fronts must be removed. All brick walls must be replaced - "Reconstruction" economically unwarranted.

Parts of foundation walls of a previous building reused in the construction of this station.

Natural Foundations "Poor."

Brick work "Very Poor" - Poorest found in any station. Wide open joints.

Apparatus Room Floor supported on structural steel frame with Reinforced Concrete slab. Seems OK under present maximum wheel load of about 8,000 lbs. Shows no cracks of any importance. One cracked panel on Drumm Street side under Hose Tender. Thickness of Floor Slab and Reinforcement is unknown - probably about 5" thick with mesh reinforcement. Maximum wheel load should be limited to 8000 lbs. as at present.

No Lateral Stability in design in view of very poor brick work in both wings of building. Two test holes were cut - one in Commercial Street wall of Main Apparatus Room - one in west wall of Sacramento Street Wing. Second story floor reported to be single thickness of 7/8 x 4" T & G on wooden joists. Many large openings in all first story street walls. Not designed for Lateral Forces.

Quarters - not crowded, altho 51 men in 49 beds. Large pool of water stands in basement. Believe it breeds mosquitoes - men complain of mosquitoes but think they come from outside the station.

Maintenance - "Fair" inside, but "Poor" outside. Windows and roof structures need paint.

Built in 1917 - Engine #8 - Type "C" - Group III - Twin House. Light, Complete, Steel Frame in Side Walls only.

Recommendations:- A Reconstruction Project - Advise a full analysis by competent Licensed Structural Engineer. Very similar to Engine #3 in that it is badly overcrowded so that reconstruction may not be economically warranted but there is a vacant lot adjoining, and an expanded station may be possible. Remove Terra Cotta Roof tile over front wall - Priority #1.

Natural Foundations sand - somewhat sloping - rated "Fair."

Apparatus Room Floor is ground supported and capable of carrying full standard 11,000 lb. wheel load.

Laterally unstable - Steel frame can be stiffened but there are no steel columns in front and rear walls which will probably have to be rebuilt. The East Wall ( and probably the west wall also) is cracked from top to bottom where the steel framing ends near front and back of the building.

Terra Cotta Roof Tile on roof over front of building should be <u>immediately</u> removed.

Brick work is "A-1" or "Excellent."

Quarters very much overcrowded - designed for 24 men - now 42 men and 34 beds. Heating system good, but old and badly in need of repair.

Lighting system not very good.

Maintenance - Needs outside painting of windows, doors, skylight, vent pipes, roof decking, etc.

Heating system probably needs replacement.

Built in 1917 - Engine #4 - Type - Class "C" - Group II
Front Wall Brick & Terra Cotta.

Recommendations:- "Reconstruction" - this Station should probably be "abandoned" due to its overcrowded condition, and probable expense of Reconstruction. However, its brick work is rated "Excellent" and so I believe a complete engineering study by a competent Licensed Structural Engineer is warranted. Front and Rear walls may have to be rebuilt and reinforced concrete slab of Apparatus Room Floor may have to be rebuilt to take full Standard 11,000 lb. wheel load. Structural Steel girders and beams of first floor are sufficient. In any event, Terra Cotta ornaments should be removed from front of building.

Natural Foundations - probably "Poor" and uncertainty introduced by use of old foundation walls from previous building.

Brick work "excellent."

Apparatus Room floor - OK under present loads. No cracks or signs of weakness. Should be limited, however, to present maximum wheel load of 8850 lbs. - not safe for 11,000 lbs.

Lateral Stability probably "Poor" - full engineering study is immediately advisable. Partial steel frame is of no value for this purpose as it stands. Floors are not designed as horizontal diaphragms. There are large openings in front and rear walls and overhanging architectural Terra Cotta ornaments, on front walls.

No lateral strength provided for in original design.

Quarters - "very crowded" - 48 men in 30 beds. Toilets - 3, urinals- 1, showers - 3.

Kitchen-Luncheon facilities in basement with artificial ventilating system which does not work.

Maintenance - "Fair."

Trussed rafters carrying Hose Racks on roof should be investigated for overload and strengthened if necessary.

Built in 1918 - Engine #17 - Type - Class "C" - Group II - Front Wall Terra Cotta and Brick.

Recommendations:- A Reconstruction Project. This is a peculiarly designed project having a partial steel frame with steel columns in the west exterior wall but none in the east wall. The west wall is a 13" curtain wall built between these columns while the east wall is heavier than normal being 21" thick in the first story and 17" thick in the second and third stories. This structure seems to have been built on old foundations and basement walls of a previous building which may explain the peculiar design.

I believe a full engineering analysis by a competent licensed Structural Engineer is warranted.

The front wall should be stripped of its Terra Cotta Ornaments and Terra Cotta Roof tile should be removed from above it. It may have to be entirely reconstructed.

Unbraced west wall rear corner in third story is dangerous in case of earthquake and should be removed.

Natural Foundations - "Fair."

Apparatus Floor of Structural Steel and concrete shows no defects under present loads. Should be checked. Slab Reinforcement is not shown on plans. Type and dimensions must be ascertained before full standard rating can be fixed. Is OK for present loads and might be rated safe for 7200 lb. wheel load.

Lateral Stability was not designed into this building. It is a definite earthquake hazard. West unbraced third story wall and Terra Cotta cornice, ornaments and mansard roof tile covering should be removed as an emergency matter.

Brick work rated "Fair." Test made in West Wall. East wall should be immediately tested and if found "Poor" rating for this station should be changed from "Reconstruction" to "Abandon."

Engine #17 - (Continued)

Recommendations:- Quarters - Somewhat crowded - 21 men - 21 beds. Three showers but only one usable. Kitchen - "Poor" and small- no natural ventilation. Located in basement - Ventilating system entirely unsatisfactory - Not working at present.

Hose hoist to roof not working - two ventilating systems "entirely unsatisfactory."

Kitchen stoves need repair.

Maintenance - Exterior "Poor."
Interior "Fair."

Built in 1925 - Truck House #1 - Located in Multi-story Class "B" Building at 420 Jessie Street.

Recommendations:- This station is located in the first and second stories and basement built by Hale Bros. for General Merchandising purposes and leased to the city. It is a twin station, generally of reinforced concrete. But the Fire Station has a tile central longitudinal dividing partition between its two sections. It also has a limited amount of ornamental Terra Cotta on its front wall which is of brick built between Reinforced Concrete Columns.

To investigate the safety of this Station would require a complete investigation of the entire multi-story building of which it is a part.

Such an investigation is completely beyond the scope of this report.

The Terra Cotta Tile dividing partition might well be removed, however, and metal lathe or similar construction substituted to advantage while the fall of this partition might not trap the apparatus in a quake, it could easily injure some of the men. The Architectural ornamentation over and about the main entrance should be removed.

The original investigation of plans made by the Bureau of Building Inspection of the City at the time this multi-story structure was approved for construction is undoubtedly on file in the records of that Bureau. It no doubt meets the requirements of the Building Code in effect in 1925.

Apparatus Room Floor seems OK under present loads - No cracks.

Foundations - sand - "Fair.

Quarters - somewhat crowded.

Kitchen in Basement - no natural ventilation. Ventilating system is in poor condition and gives unsatisfactory results.

Subsurface gasoline tank in sidewalk area is in disrepair and out of service. Two 50 gallon hand carts act as substitutes.

Maintenanance - Some inside painting needed.

Built 1918 - Engine House #37 - One Story Type - Class "C" - Group I - for Motorized Vehicles. Brick Walls trimmed with Granite and Terra Cotta.

Recommendations:- Recommended for complete study by a competent licensed Structural Engineer. This is a one-story rambling brick and wood structure. Apparatus room 17'8" high with ridged trusses resting on brick walls. The Apparatus Room walls probably need strengthening and Terra Cotta roofing tile should be removed from eaves which overhang entrances.

Unfortunately the brick work has been rated as only "Fair and Structurally Weak" (i.e. only low stresses must be permitted in any mathematical analysis), and therefore I believe a complete study should be made, including a more complete investigation of the character of all brick work. It is therefore rated as a Reconstruction Project. Its rehabilitation will be of comparatively low cost, I believe, and fully warranted unless influenced by the overcrowded condition of the station or by further and adverse findings of the condition of the brick work.

Natural Foundations probably "Good."

Brick work:- Brick is soft - mortar is soft and white, probably lime-mortar. Bricks not well wetted showed lack of adhesion. Joints in general full, except in ends of outside headers were half empty.

Apparatus Room Floor is on ground and therefore good for full standard 11,000 lb. wheel load. Strength of roof trusses over Apparatus Room should be checked.

Lateral Stability to be fully investigated - has has not been designed into the structure originally.

Quarters - much overcrowded. Designed for 23 men, now 38 men in 28 beds. Only 2 showers and 3 toilets for 32 men.

Kitchen-Luncheon space too small for the crew.

Maintenance - Lighting System "Good" but said to be overloaded.

Heating System - "Good" but needs some attention. Said to be some leaks and much broken tile on roof.

Brick work of north wall starting to disintegrate at vent openings due to rust for lack of paint on metal vents and lintels. Entire roof is Terra Cotta tiled. Doorways to Apparatus Room are said to be very narrow for the large apparatus housed.

Built 1923 - Engine #39 - Type Class "C" - Group III

Recommendations:- "Abandon" Dangerous - Priority Rating Group #1. This station is distinctly earthquake hazardous and with concentrated floor loads carried by 17" x 17" brick piers (or if you will first story walls with 4" x 17" pilasters) and brick work rated "Fair to Poor" is liable to complete collapse. It has a high ornamental tower (not intended or usable for drying hose) overhanging the Apparatus Room and a free standing brick chimney extending 13' above the roof of the "Living" or "Communication" Room roof. Also, very much "Overcrowded." I believe Reconstruction economically unwarranted.

Foundation - Probably Red Rock rated "Good."

Apparatus Room Floor is ground supported and therefore good for full standard 11,000 lb. wheel load.

Brick work was laid with 8" common red brick on inside of walls plus a somewhat better quality 4" thickness of facing brick on outside in what proved to be a false Flemish Bond. The header courses of the Flemish Bond were found to be only half headers and did not run into the 8" backing. (Possibly a few did at every sixth course. We did not investigate this). A definite plane of weakness was found to exist between the face brick work and its 8" backing. In this plane vertical joints were either fully open or only partially filled, as were all joints immediately back of the immitation or half headers.

Lateral Forces have apparently been given little if any consideration in the design. The 17" x 17" brick piers taking concentrated second story loads from 20" x 65" steel I Beams in 30' spans make, in my opinion, this building more likely to complete rather than partial collapse. In any event the tower which apparently was purely ornamental and not intended for any use must come down as must the free standing brick chimney. Roofing tile at the eaves overhanging the main entrance must also be removed.

Engine #39 - (Continued)

Recommendations:- Front wall is almost entirely openings. There are also many in some of the side walls.

Quarters are "Very much overcrowded." There are 42 men in 22 beds in a building designed for 20.

Kitchen-Luncheon space is impossible for the size crew, and lunchers must overflow into the Communications Room which is also officers' work-room.

Main Entrance is low and prevents the housing of certain types of apparatus.

Maintenance "Fair" inside and out, except metal chimney which needs paint badly.

Built 1926 - Engine #16 - Type Class "C" - Group III

Recommendations:- "Abandon" Dangerous - Priority Rating Group #1. This station is distinctly earthquake hazardous with concentrated floor loads carried on 17" x 17" brick piers and brick work rated "Fair to Poor." I believe Reconstruction economically unwarranted.

Natural Foundations - uncertain.

Apparatus Room Floor OK for full Standard 11000 lb. wheel loads. Is supported on ground.

Brick work - Brick soft, lime-mortar soft. Joints filled except transverse vertical joints of header courses 4 out of 5 of which were unfilled for half their length in the center of the wall (i.e. filled only one-half back from face of wall.) Rated - "Poor."

Lateral Stability completely ignored in the design. Very difficult to rebuild, except by tearing down entire structure to first floor level. Front wall many large openings - has no lateral strength. Termites in front door frames.

Two brick chimneys extend above roof. Earthquake hazardous.

Quarters - crowded - Designed for 15 men now 24 with 22 beds. Six officers in four beds, 2 showers only. Sewer connection "Poor" for second story only.

First story - kitchen and toilets and lavatory facilities discharge into yard sump with pump to sewer. Yard has settled several inches around this sump. Roof leaks but has recently been repaired.

Maintenance - "Fair."

Built in 1927 - Engine #25 - Type Class "C" - Group IV.

Recommendations:- A Reconstruction Project - Priority Group II. Has a complete steel frame but not designed to care for earthquake stresses. An earthquake hazard. Almost identical in design with Engine #19. A complete engineering analysis by a competene Licensed Structural Engineer shall be made. Suggest some saving in fees should result if Engines #19 and #25 were submitted to the same engineer.

Reconstruction is economically warranted.

Natural Foundations "Poor" on filled ground near waterfront.

Foundations are carried on Reinforced Concrete Piling.

Apparatus Room Floor is believed Safe under full Standard wheel loads of 11,000 lbs. (See Engine #19).

Brick work rated "Fair to Good" - Not so good as in Engine House #19.

Shows no evicence of having been designed to resist Lateral Forces, therefore is an earthquake hazard though probably not in danger of complete collapse. Should be strengthened Believe not too difficult.

Quarters - OK - not crowded.

Extensive Wooden Hose racks in yard are a fire hazard.

Maintenance - Exterior - "Poor."
Interior - "Fair."

Windows need outside paint. May be some dry rot in wooden flooring on first floor or possibly termites. Should be further investigated.

Built 1928 - Engine #19 - Type Class "C" - Group IV.

Recommendations:- A Reconstruction Project. Priority Group II. Has a complete steel frame but not designed to care for Lateral Forces. Might be damaged in a severe earthquake. Full analysis by a competent Licensed Structural Engineer advised. Reconstruction is economically warranted, I believe.

Natural Foundations - "Poor" on filled ground and bay mud adjoining waterfront. Foundation carried on Reinforced Concrete Piling.

Apparatus Room Floor is of Reinforced Concrete. This station houses one of the heavy type of Fire Boat Hose Tenders with a full Standard 11,000 lb. wheel load. The floor shows no cracks or other evidence of weakness, so I am rating it safe for full Standard loads. The mathematical calculations show a considerable overload.

Brick work is rated "Good."

Not designed to resist seismic forces. Must be strengthened in this respect. In its present condition rated an earthquake hazard. Believe such strengthening not too difficult. There are no heavy overhanging ornaments on front wall.

Quarters OK - designed for 14 men, now housing 25, but not considered crowded.

Kitchen-Luncheon facilities somewhat small.

Maintenance - Needs paint both inside and outside.

Flooring of Hallway from North entrance is affected by termites or dry rot - should be repaired.

Built 1928 - Engine #29 - Type Class "C" - Group III.

Recommendations:- This station has already been slated for removal because the property is required by the State Highway Department for its 13th St. Lateral, so no recommendation by me is necessary. However, as there may be some delay in its removal, I might point out that this station is in the same Group and is quite similar in design to Engine House Nos. 16 and 39, which have been classified as earthquake hazardous.

Its brick work is, however, somewhat better than theirs and has been rated "Good but Structurally Weak." Also, I believe it is somewhat better supported laterally by its two side wings.

A complete investigation did not seem warranted.

Built 1929 - Engine #47 - Type Class "C" - Group V.
Part brick and part Structural Terra Cotta Tile Walls.

Recommendations:- A Reconstruction Project - Apparatus Room section of the building is unstable for Lateral Forces - Complete analysis and study by Licensed Structural Engineer is necessary. This section of building has 12" thick walls largely of structural Terra Cotta Tile, but with some brick work. Balance of building is of brick and wood and is probably OK. Believe the situation warrants the cost of engineering study with preliminary sketches and estimate for Reconstruction.

The Reconstruction is probably economically warranted.

Natural Foundations sand and "Good."

Apparatus Room Floor on ground is OK for full Standard 11,000 lb. wheel loads.

Brick work rated "Good," although some re-pointing of brick work in south wall is necessary.

Structural Tile unreinforced walls are a discredited form of construction in earthquake zones. In addition the tile wall on the south side has many partly open joints, resulting from weathering and is in bad condition. All tile walls should be removed.

A "very poor" design from the point of view of Lateral Stability and a bad earthquake risk. A complete steel frame exists in the Apparatus Room section and may possibly be sufficiently strengthened if used with light covering walls possibly of light-weight concrete (instead of brick) to give proper earthquake resistance.

Diagonal trussing in Attic Space has been installed only at 4' 0" centers instead of 2'0" centers as per plans. Nailing is also very light; should be doubled. Roofing tile must be removed over wall at Apparatus Entrance.

Engine #47 -(Continued)

Recommendations:- Quarters - OK - not crowded.

Heating and lighting "Good."

It is an item of interest that this station was built with a complete interior emergency or standby gas lighting system.

Maintenance - Interior - "Good."
Exterior - "Poor."

Windows, sheet metal chimneys, etc. need paint badly.

Built 1931 - Engine #49 - Type Class "C" - Group V.

Recommendations:- A Reconstruction Project and a bad earthquake risk. Apparatus Room section has a complete but light and totally unbraced steel frame with walls of strucural tile unreinforced, a completely discredited type of construction from point of view of earthquake resistance. The remaining rear portion of the station is of frame construction. The dividing wall between the two types of construction is of wood in the second story leaving the entire station without protection, let us say for example in an incendiary bombing I question whether the cost of salvaging this station is warranted. However, it undoubtedly can be done at a price. All tile walls should be removed and rebuilt. A complete study by a Licensed Structural Engineer is suggested.

Natural Foundations - sand, rated "Good."

Apparatus Room Floor is ground supported and is OK for full Standard 11,000 lb. wheel load.

Lateral Stability "Poor."

Not designed to resist horizontal forces. Unreinforced structural tile walls are a discredited form of construction in earthquake territory. Terra Cotta Roofing tile should be removed from eaves of front wall. All tile walls should come down and be replaced with other material, possibly "lightweight" concrete.

Quarters - "good" not crowded.

Kitchen facilities - "Good."

Heating and Lighting - "Good."

Maintenance - "Fair."

Pivoted steel windows need care of movable sash.

Built 1938 - Engine #20 - Type - Class "C" - Group V - Twin Station.

Recommendations:- A Reconstruction Project economically doubtful. A very poor structural design, combining a large twin apparatus room section, having a light-weight and unbraced steel frame with 6" structural Terra Cotta enclosing wall, with a rear section of wood and stucco overlapping the Apparatus Room section in the second story, but with no fire barrier between. This building in my opinion would be in danger of complete collapse in an earthquake of the severity of 1906. All tile walls must be removed. Unreinforced tile walls are a discredited construction in an earthquake belt and to make matters worse these are but 6" thick. A complete engineering study and estimate by a competent Licensed Structural Engineer may be warranted.

Natural Foundations - "Fair" - probably clay.

Apparatus Room Floor is ground supported and good for full Standard 11,000 lb. wheel load.

Little lateral stability at present. Not designed for horizontal forces. But complete steel frame in Apparatus Room section can, I believe, be braced and combined with light-weight concrete walls to become earthquake resistant. Cost will be large in comparison with the value of the present station. Terra Cotta eaves tile should be removed from Roofs and Eaves over all Entrances.

Quarters - very much overcorwded.

Designed for 21 men - now 42 in 27 bed.

Kitchen-Luncheon Room much too small (11" x 13") Men must set up lunch table in Communications Room.

Maintenance "Good."

Note:- In view of the Overcorwded condition of the Station "Abandonment" might be warranted.

Built 1939 - Engine #35 - Type Class "C" - Group VI - 3 Section Station - Reinforced Concrete Walls and Frame. Wooden joist, etc. in second floor and roof.

Recommendations:- Continued Use as is.

Building is safe for a maximum concentrated wheel load of 8850 lbs. and is earthquake resistant in my opinion.

Natural Foundations "Poor" - Filled Ground. Foundations are on piles. Some doubt is cast upon them by the fact that foundations for a previous building were used in part for this one. However, I saw no evidencing of cracking or settlement.

Apparatus Room Floor is of reinforced concrete believed safe for a Standard 8850 lb. wheel load. This eliminates the housing in it of only the two heavy Fire Boat Hose Tenders.

Lateral Forces. This is one of the few stations in whose design it seems probable that lateral forces were given consideration. This could not be substantiated as the Structural Designer, Mr. Joseph Snyder of the Bureau of Engineering of the city is now deceased. But whether it is so or not I find by rough approximations that there is sufficient strength in the structure to rate it earthquake resistant.

Quarters - Satisfactory - not generally crowded. But 3 Battalion Chiefs have space for but 2 beds. Lavatory facilities "Good."

Kitchen-Luncheon space OK, but somewhat small.

Maintenance "Good."

Built 1940 - Utilities Dept. - 840 Octavia Street - Type Class "C"
Group VI - Reinforced Concrete
Walls and wood interior.

Recommendations:- No Plans are available - Building is much the same in character as those of Group I, except walls are Reinforced Concrete instead of Brick - Probably OK except for front wall which has large openings in first story. May have to be strengthened to resist earthquake forces possibly by the addition of a steel frame.

Natural Foundations - probably "Fair."

Apparatus Room Floor is ground supported and can carry full Standard 11,000 lb. wheel load.

Lateral Resistance uncertain. Should be checked and stiffening added if necessary. If plans can be found little study will be needed. No way to make complete investigation without plans or considerable cutting of plaster and some concrete for which funds not at present available. Plans should be found - built in 1940. If plans cannot be found a complete engineering study should be authorized.

Maintenance "Good."

Probably a minor reconstruction project.

Built - Fire Boat #2 Station - Type "Frame" as a part of Pier Shed on bulkhead wharf, at Pier #35 - Embarcadero - Foot of Bay Street.

Recommendations:- Safe for both vertical and lateral forces, but the entire Station and housing facilities on the Fire Boat wharf are obsolete and inadequate as living quarters for 37 men and should be replaced and modernized. Beds and lockers are in short supply.

Kitchen-Lunch space is not at all sufficient. Lunch table must be set up in Communications Room.

Plumbing fixtures are of obsolete type and small in number. 1 Shower for 37 men - beds and lockers are short in number. Food lockers on fire boat wharf are only there because donated by the department employees and are of wood and rat infested. Metal lockers should be at once supplied.

Lighting facilities are obsolete and inadequate.

Recommend "Abandonment" or complete "Reconstruction." This, however is not an emergency project. The station is, I believe, at present structurally safe as a part of the State owned wharf structure.

This station houses at present the heaviest type of Fire Equipment - one of the Heavy (Fire Boat) hosetenders having a rear axle load of 22,000 lbs.

Apparatus Room area is very limited.

Quarters -

This character of accomodation lowers departmental morale - would probably not be accepted outside of Civil Service or pensioned employment.

Maintenance- "Poor."

Built 1942 - Engine #32 - Type - Frame with partial steel frame.

Recommendations:- A Reconstruction Project - probably of minor cost. Structure not designed to care for lateral forces, therefore an earthquake hazard.

Apparatus Room needs lateral bracing by strengthening connections between various members of the steel frame in the Apparatus Room. I believe this weakness can be corrected.

Natural Foundations probably "Good."

Apparatus Room Floor is ground supported and safe for full Standard 11,000 lb. wheel load.

No evidence that lateral forces were considered in the design. Frame portions of Station are probably now earthquake resistant. But steel frame first story of Apparatus Room section is improperly connected to act as a continuous frame and give lateral stability. These connections should be strengthened. My limited investigation seems to show that the main members are of sufficient strength. Further engineering study is advised.

Quarters - Very nice - not crowded.

Heating and lighting "Good."

Kitchen-Luncheon facilities "Good" but new sink badly needed.

Hose Racks in yard need protection from rain.

Maintenance - None since construction completed
Interior - "Fair" condition.
Exterior - "Poor" - Windows in need of paint.

Built 1950 - Engine #27 - Class "1-A" (Rating of S.F. Building Code of 1947)

Recommendations:- "Continued Use" - the structural features of this structure were designed by a well known Licensed Structural Engineer, employed by the Architects. It has been designed in accordance with the structural requirements of the 1947 Building Code, and passed by the Bureau of Building Inspection of the City. It is undoubtedly structurally safe under vertical loads and earthquake resistant.

Natural Foundations "Good."

Apparatus Room Floor ground supported.

Quarters - Already overcrowded with six officers sleeping in two beds alternately. Three companies now quartered in a two-company station. This condition said to be temporary, but ---

Maintenance - Some minor shortcomings which should be corrected by the general contractor who built the station.

Built 1951 - Engine #30 - Type Class "1-A" (Rating of S.F. Building Code of 1947)

Recommendations:- "Continued Use" - The structural features of this station were designed by a well known Licensed Structural Engineer, employed by the Architects. It has been designed in accordance with the structural requirements of the San Francisco Building Code of 1947 and passed by the Bureau of Building Inspection of the City. It is undoubtedly structurally safe under vertical loads and is earthquake resistant.

Natural Foundation is sand, rated "Good."

Apparatus Room Floor is ground supported.

Quarters - Station was put into service September 23, 1951.

DEPARTMENT OF CITY PLANNING
100 LARKIN STREET
CIVIC CENTER
SAN FRANCISCO 2, CALIF.

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